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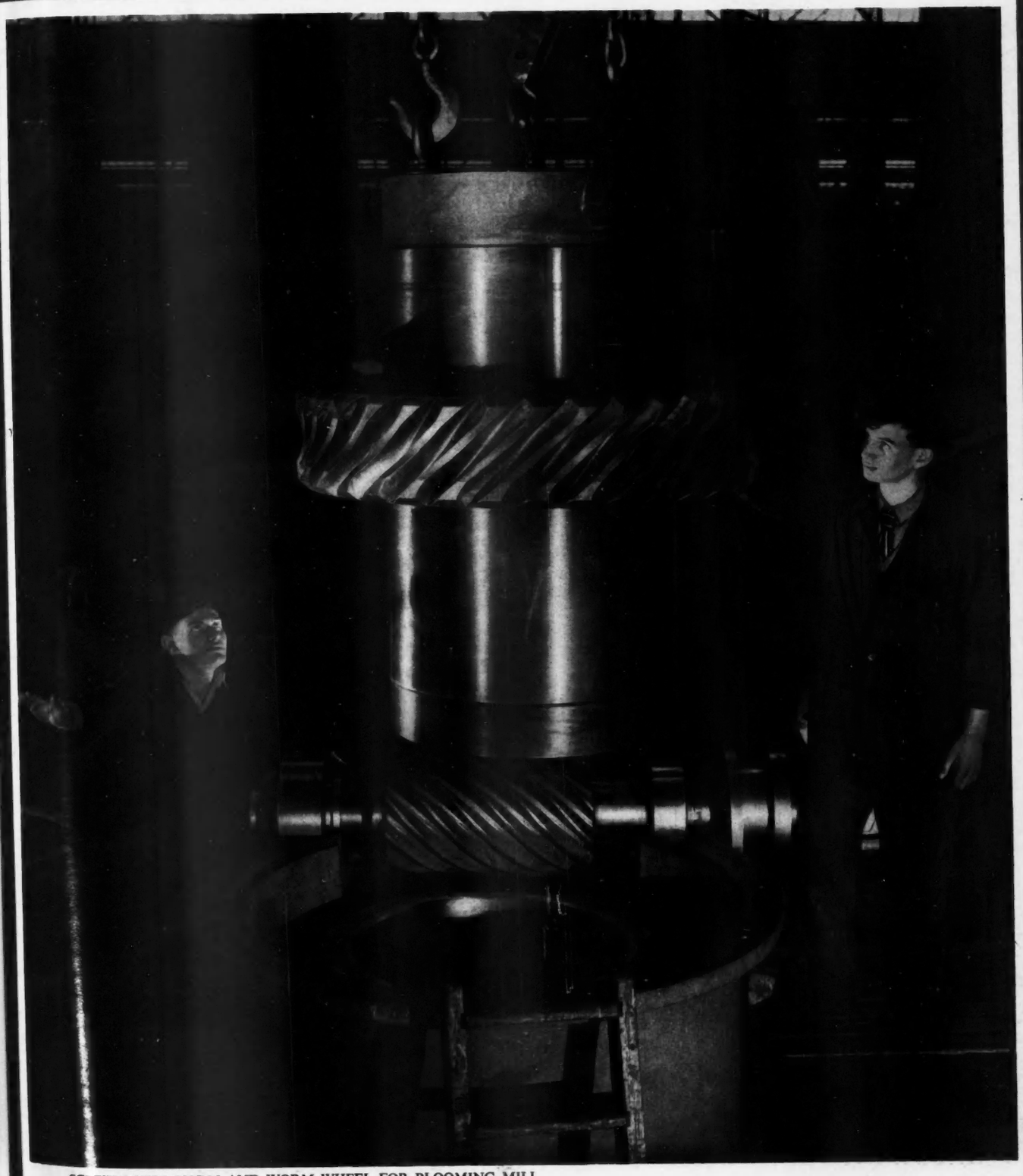

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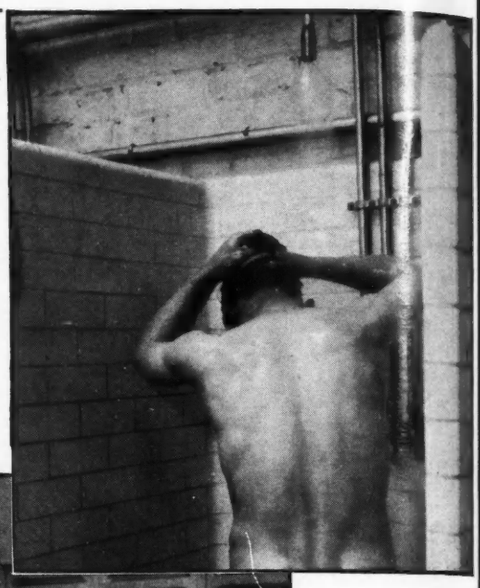

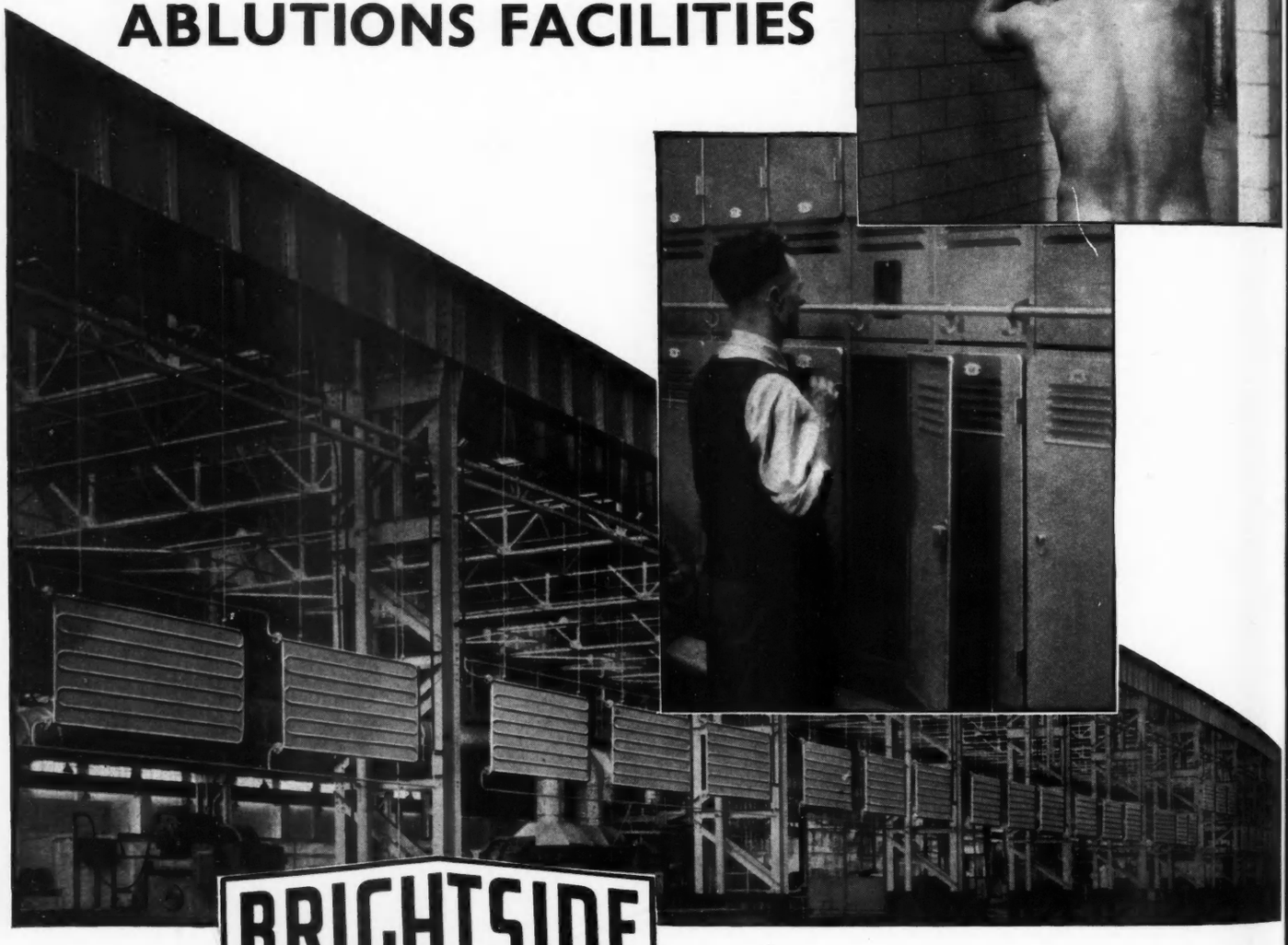

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ENGINEERING

An Illustrated Weekly Journal

Vol. 177 No. 4590 JANUARY 15, 1954

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CONTINUITY OF SUPPLY

THE custom of celebrating the memory of famous men by periodical reviews of some aspect of their work, though commendable, is not without its pitfalls. For, as pointed out by Professor P. I. Dee, in delivering the forty-fourth of the series last spring, even in the case of so prolific a pioneer as Kelvin the vein becomes worked out as the years pass. The result is that these lectures are coming to have less and less connection with the activities of him whose name they bear.

The same comment might be made with equal, if not greater, truth of the lectures which are delivered periodically in honour of Sir Charles Parsons. For, although he was a great engineer, it is fair comment to say that the scope of his work was more limited than that of Kelvin's. Unless therefore repetition is to be allowed, the connection between that work and the subject matter of the lectures may become increasingly difficult to maintain.

In preparing the 1953-54 Parsons Memorial Lecture, which he delivered before the Institution of Electrical Engineers on January 7 (as reported on page 76), Mr. H. Leyburn clearly recognised this dilemma. Admitting that he had no direct or special knowledge of Parsons' work, he argued, by the exercise of what might almost be described as poetic licence, that as the steam turbine was playing an important if indirect part in ensuring a continuous supply of electricity, it was legitimate to connect that subject with his name. Mr. Leyburn's lecture brought out a number of important points in a field which, in its technical aspects, is largely the preserve of specialists though its repercussions affect industry and the public generally.

To achieve continuity of electricity supply, three conditions, as Mr. Leyburn rightly contended, must be fulfilled. First, the multiplicity of equipment which is now embodied in a power system must be designed and manufactured in such a way that it will operate satisfactorily when conditions are normal. Mr. Leyburn did little more than mention this aspect of the subject, and that he was able thus to dismiss it is a tribute to the success of the work which has for so long been performed in these fields. Secondly, measures must be taken to overcome the effects of disturbances when they occur, and thirdly, means must be found of avoiding the interruptions that these disturbances may, in spite of all precautions, bring about. To this last condition may be added the corollary that on the larger inter-connected systems that are now customary an interruption of electricity supply must, as far as possible, be localised.

An examination of the situation in the light of these conditions discloses the result, which may be surprising to many, that even in Great Britain lightning is responsible for about 40 per cent. of the disturbances that take place on overhead lines, and for about 20 per cent. of the total of all such occurrences. Considerable research has perforce been directed to the discovery of the mechanism and characteristics of lightning strokes, and a number of devices have been designed to provide protection against their effects.

Another prevalent cause of breakdown is insulation failure, although the number of such failures is being reduced by improvements in design as well as in manufacture and testing. There remains the human element in all its numerous manifestations. None of these potential causes of discontinuity is entirely avoidable. In fact, it is impossible to eliminate faults. The best that can be done is to limit their effects by such expedients as providing different insulation levels on different apparatus and even on parts of the same apparatus, thus reducing the incidence of flashovers.

This, however, does not go far enough in the pursuit of continuity. To approach it, protective apparatus which will discover and locate the fault, and circuit-breakers which will remove or isolate it, must be employed. Jointly, these two classes of equipment minimise the damage by the fault at the place of its occurrence, ensure that healthy pieces of equipment are not affected and avoid the dislocation of the power system through instability. With the increasing concentrations of power and the more extensive interconnection of generating stations, it is necessary, again in the cause of continuity, that these duties should be performed with extreme rapidity. In fact, clearance must take place in 0·2 second or less from the appearance of the fault – a difficult condition which the designers of protective apparatus and circuit-breakers have been largely successful in meeting.

Praise is due to those whose ingenuity has rendered electricity supply so reliable that it is taken for granted, but that position has not been reached without considerable financial expenditure. It may be argued, in fact, that in the sphere of protection particularly, the complication of design has been allowed to go too far and that some simplification and, with it, cheapening of the equipment should now be the principal objective of research and design.

Weekly Survey

UNIFORMITY IN DRAWINGS

The distribution of engineering work in the form of sub-contracts has an increasing part in the specialised industrial activities of to-day. It is therefore essential for the drawings of one firm to be understood by other organisations and for articles made by different companies to be uniform and interchangeable. Government contracts, in particular, are seldom the sole responsibility of one manufacturer. It is also important for universities and technical colleges to have a basis for instruction in design and draughtsmanship that will enable the student to be familiar with practices in whichever branch of industry he eventually finds himself.

It is with these factors in mind that the British Standards Institution have published B.S. 308, *Engineering Drawing Practice*. The Standard is divided into two sections, the first devoted to the unification of general drawing practices and the second to the indication on drawings of dimensions and tolerances. The object of the last section is the achievement of economies in time and materials, no less than the approach to a standard product. Tolerance limits set without regard to the function of the finished article may, if too rigorous, entail undue expenditure in production and cause the rejection of components which are, in fact, sufficiently accurate for their purpose.

The Standard introduces the principle of geometrical tolerances, for which it is hoped a widespread acceptance may be secured. The conventional system of tolerancing may permit, in parts designed to fit together, errors which are not revealed by linear measurements alone. A constant diameter, for example, is a property not only of circles and spheres. The Standard shows lobed figures to illustrate this and describes a system of tolerancing such features as flatness, roundness and parallelism.

It is realised that the same approach is not suitable for all products – in the drawing office as in the workshop – but it is believed that a common foundation for drawing practice will yield considerable benefits. This will be especially true if overseas companies adopt similar standards and it is understood that the Canadian and American Standards Associations, the International Organization for Standardization and corresponding bodies on the Continent and in Australia are shortly to publish standards based on the proposals incorporated in B.S. 308.

It is therefore hoped that not only will the practices described in the Standard be adopted throughout British industry, but also that the Standard itself will become a text-book in universities and technical colleges. A more detailed notice of the Standard appears on page 71.

* * *

A MODERN PIPE-LINE

During recent years, the problems associated with transport have multiplied and the solution has often meant departure from the established use of vehicles. In particular, in the oil and petroleum industry, transport by vehicle has been abandoned for many purposes in favour of continuous pumping through pipe-lines. Many such lines have now been constructed, some to carry crude oils from the oilfields to the refineries and thence to the shipping points, and other systems have been laid to distribute the saleable product to the consumer.

Distribution by pipe-line, however, is by no means new. Traces of piped-water systems, for example, have been found in the excavations made at the sites of the earliest civilisations. Yet, in spite of the long experience of the construction and operation of piped services, there are still many factors in the design of major pipe-lines that have to be resolved.

Some of the features of a modern pipe-line are described in the article, on page 78, concerned with the Trans-Northern Pipe-Line, built by three oil companies in Eastern Canada. An operational feature of this particular line, which will be used by all three of the companies, is that it will be used to handle (at different times) as many as nineteen different petroleum products, including motor spirit, Diesel fuel, stove and furnace oils, as well as liquified petroleum gases.

By a closely-controlled system of dispatch, by accurate metering of both the input as well as of the product at the delivery points, and by the adoption of modern techniques of pressure control and turbulence so that commingling of successive "tender heads" is minimised, it is expected that the three companies will be able to deliver, with a negligible wastage, the products that they individually consigned from Montreal, where their refineries are located.

Another feature of this system is the use of indicator and recording instruments of the strain-gauge type so as to eliminate the hazards normally involved when liquid-carrying control lines have to be brought into the control rooms. An elaborate system of indicators gives immediate warning of the development and location of a leak, or of the other types of failure which may develop in a high-pressure pumping system handling highly-inflammable liquids.

* * *

TELEVISION FOR INDUSTRY

Although of very recent origin, the uses of television in industry have increased extremely rapidly. The possibilities of the closed-circuit system offer a wide choice of applications without the need for expensive transmitting equipment or a Post Office licence.

One of the obvious uses is for monitoring operations which it would be difficult or dangerous for human observers to approach; no such restrictions apply to the scanning tube. It can be placed exactly where it is required and will relay faithfully all that happens. A similar use is where space is restricted around an operation which many wish to observe. The picture can be relayed to another room and projected on a screen, by one of the several methods now available, so that it can be watched by a large audience. An example of this is given in our article on page 88, where a machining process is shown being projected for the instruction of students. Projection has also been used in hospitals for surgical operations, and here there is another advantage of a closed-circuit system, for colour can be introduced more easily than with a broadcast network.

In America, television has been introduced in some shunting yards, to aid traffic control. The camera is placed so as to observe the destination card of the wagon and relay it to the man at the control desk. This enables him to route the wagon to the appropriate siding at once, without the necessity for verbal messages from the shunter in the yard. Similarly, observation can be maintained on the movements of lorries at loading bays. In both these examples, there is the underlying advantage that exposure to inclement weather is reduced.

Another advantage is that the number of receivers is not limited. A single camera can be connected to feed several widely scattered receiver units and enable people who may be in different buildings to observe the operation simultaneously. Or a single building may be wired up so that the picture can be seen in each room, and individuals can make particular sets of observations without interference from others.

A field of operation where much development work is being done is for observation under water. Some idea of the important possibilities of this was brought home by the visual identification of the submarine Affray. The first rather blurred pictures of the name revealed the possibility of checking events which till then could only have been guessed. Now several firms are engaged on this work and one type was shown at the Engineering, Marine and Welding Exhibition at Olympia last September. Television can now no longer be regarded as merely a means of entertainment, but also as a very useful aid to industry and production.

* * *

ROLLING STOCK

The rolling-stock building programme of British Railways for 1954 (reported on page 70) is a marked improvement on the annual programmes which the Government have allowed since the war. It is a sign that the railways are at last able to overtake the very considerable arrears of maintenance and renewal which accumulated as a result of the war. New plants for the production of coaching stock and wagons, using modern methods of fabrication and line assembly, have been ready for some time but have not been fully employed. Restrictions were imposed because of the shortage of steel. This phase is now past – though shipbuilders still have complaints in respect of certain classes of steel.

The number of locomotives to be built (325) is not particularly large in relation to the total operating stock, which numbered 18,874 for all types – steam, Diesel, electric and gas turbine – at the end of November last. Since the nationalisation of the railways in 1948, however, some reduction has been achieved in the total number of locomotives, partly by economies due to the co-ordination of operation, and partly, no doubt, as a result of the closing of uneconomical branch lines. Details of the design of the standard Class 9 heavy freight locomotives which are included in the 1954 programme will be published within the next few weeks. This design will be the tenth in the series of twelve standard designs which British Railways are building. It has a 2-10-0 wheel arrangement. The remainder of the locomotive building programme appears to follow established practice, except that mechanical drive is evidently preferred for the 14 Diesel shunting locomotives which are to be built.

If the locomotive stock is only requiring normal replacement and modernisation, carriages and wagons are still not sufficient in quality or quantity. The number of passenger-train vehicles to be built this year – 2,750 – may be compared with the total operating stock at the end of November, namely, 57,203. Since the latter figure was 5,000 more than the stock a year before, the position is clearly improving. The programme for this year should allow more of the obsolete vehicles to be scrapped.

Private builders will have a greater share of the wagon building programme than of the locomotive or carriage work. They are to build about 23,000 out of the total of 53,000 wagons. The total operating stock of freight vehicles last November was 1,121,945. If the civil engineering departments of British Railways can similarly increase the amount of work they undertake this year, there should soon be nothing to prevent the full restoration of fast running and more punctual working.

Letters to the Editor

CALCULATION OF THE THICKNESS OF HIGH-TEMPERATURE STEAM PIPES

SIR, In reference to the correspondence between Dr. F. van Iterson and Dr. J. S. Blair on page 723 of your issue of December 4, may I ask Dr. van Iterson, through you, on what evidence he bases his emphatic assertion that the Coulomb-Tresca or Guest criterion of yield gives the correct result ?

He says that other theories of plasticity lead to flow pressures which are " only a few per cent. higher " than those derived from the Guest criterion. I should like to point out that, assuming no strain in the axial direction, the adoption of the more widely accepted Mises-Hencky or Maxwell criterion of yield coupled with the Lévy-Lode stress-strain relationship, would lead to results differing from those of the Guest criterion by the factor $\frac{2}{\sqrt{3}}$. This represents a difference of more than 15 per cent.

Yours faithfully,
E. VOCE.

Copper Development Association,
Kendals Hall,
Radlett,
Herts.
December 30, 1953.

DYNAMICAL ANALOGIES

Vibrating Beam and Electric Transmission Line

SIR, I feel that an assertion made by Mr. R. Yorke in his British Association paper (" Dynamical Analogies," page 763, issue of December 11, 1953) must be questioned. He states that the electrical analogue to a cantilever in vibration is an electrical transmission line.

I gave some thought to producing an electrical analogue to a vibrating beam some time ago and while feeling intuitively that the transmission line was the answer, I did not succeed in proving the analogy.

Subsequent consideration has convinced me that the transmission line is not in fact an analogue to the beam.

The equation relating displacement y (treated as a vector with respect to time) with distance x along a cantilever or other beam is $\frac{d^4y}{dx^4} - m^4y = 0$, where m depends upon the excitation frequency, the section of the beam and the elastic modulus, and is constant for a uniform beam.

The equation relating current, I, to distance x, along a transmission line is $\frac{d^2I}{dx^2} - \sqrt{\frac{L}{C}}\, I = 0$, where L and C are the inductance and shunt capacitance per unit length at the point x, the resistance being taken as negligible.

The solution to this second-order equation contains only hyperbolic functions, while that to the fourth-order equation representing the beam contains both hyperbolic and trigonometrical functions in the cases of a uniform beam and a uniform transmission line.

It would appear, therefore, that the variation of current along the line is not analogous to the variation of displacement along the beam and, if an electrical analogue exists at all, it is something more complex than the simple transmission line.

I should be very pleased to know whether any other reader has succeeded in producing a rigorous electrical analogue to the vibrating beam as it would be a most useful means of investigating many vibration problems.

Yours faithfully,
W. M. SKENFIELD.

9, Childsbridge Way,
Seal,
Sevenoaks,
Kent.
January 6, 1954.

ENGINEERING STUDENTS IN CHINA

Communist Drive for Enrolment

SIR, A portion of your editorial of September 25, 1953 (page 401) turns on the statement " Mr. Gammell gives figures to show that only 3 per cent. of the students enrolling at American universities in 1952 were allowed (*sic*) to take courses in the fine arts, law or political science; and that by far the heaviest enrolment was in engineering." Actually, the 3 per cent. figure applies to what is going on in communist China and was mentioned to indicate the enormous drive behind science which now characterises the communist world.

The obvious implication is that we in the non-communist world must give great attention to all factors associated with the effective development and use of our scientific talent. The exact quotation appearing in my article was as follows:

" According to Robert Franklin, writing in the *New York Herald Tribune*, ' Twenty-four of every 25 students who begin a university course in Communist China this year are being prepared for a role in China's ambitious industrialization program. Only 3 per cent. of this year's university enrollment were permitted to take courses in the fine arts, law, or political science . . . . By far the heaviest enrollment is in engineering colleges '."

The percentage of engineers compared with total college enrolment in the U.S.A. is given in the following figures, taken from the *E.J.C. Engineering Manpower Newsletter*, No. 49, December 10, 1953, entitled " Scientific Research and Development in American Industry " :—

" Following are the U.S. Office of Education estimates of overall college enrollment and engineering college enrollment during the Fall of 1953, as compared with 1952 and prior years.

Year.	All College Students.	All Freshmen.
Fall of 1953	2,274,000	577,000
Fall of 1952	2,148,000	537,000

" The figures for engineering enrollments are as follows :

Year.	Total Undergraduates.	All Freshmen.
1953	191,700	60,200
1952	156,100	51,600
Ratio 1953 to 1952 ..	123 per cent.	118 per cent.

" The pre-war average of engineering freshmen expressed as a percentage of all freshmen was 8 per cent. The corresponding ratios for the last four years are as follows : 1950, 6·6 per cent. ; 1951, 8·5 per cent. ; 1952, 9·7 per cent.; 1953, 10·5 per cent. The above figures represent all engineering enrollment in accredited as well as non-accredited curricula. It is interesting to note that there has been an 18 per cent. increase over 1952 in engineering freshmen enrollments compared to a 7 per cent. increase over 1952 in overall freshmen enrollments. If current survival rates apply, about 30,000 will graduate from accredited engineering curricula in 1957."

Very truly yours,
JOHN GAMMELL,
Supervisor, Sales Training,
Graduate Training Section.
Allis-Chalmers Manufacturing Company,
Box 512,
Milwaukee,
Wisconsin, U.S.A.
January 4, 1954.

* * *

NATURAL POWER IN NEW ZEALAND

Development of Water and Geothermal Resources

New Zealand is the fortunate possessor not only of a number of sites particularly suitable for the large-scale generation of hydro-electric power, and of numerous natural lakes at high altitudes which serve as storage reservoirs, but also of geothermal areas which can be used for generating electrical power.

The largest of the hydro-electric schemes is the Waitaki River Power Development, which has a total potential of 1,600 MW and makes use of three natural lakes discharging into the Waitaki river. Two stations totalling 130 MW have already been put into operation and field tests are being carried out at a site near Benmore, where a station with a capacity of 332 MW is projected.

The next largest power scheme is the Waikato River Power Development, with a total potential of 1,216 MW. This scheme makes use of Lake Taupo for storage purposes and provides for a succession of ten generating stations on the river, of which three are now operating with a combined capacity of 428 MW. Of the remainder, one with a capacity of 100 MW is under construction.

A third scheme is the Clutha River Power Development with a total potential of 1,140 MW. This scheme also incorporates three natural lakes, which discharge into the Clutha river. At the present time a station with a capacity of 320 MW is under construction on the river near Roxburgh.

Of recent years the Government of New Zealand have been progressing rapidly with hydro-electric investigations and projects. During the year 1952-53 (according to the annual report of the Commissioner of Works) three major hydro-electric power stations were under construction, with that at Maraetai, of 180 MW, having three of its five generators feeding into the North Island grid before the close of the year. Also under construction were three lake-control works and thirteen substations. Investigations were also being conducted into nine hydro-electric projects for future construction.

GEOTHERMAL POWER

The possibility of developing geothermal power from natural steam has been studied in connection with the Wairakei and Te Teko projects, where a number of boreholes have been drilled and the construction of quarters begun. At Wairakei, twelve boreholes are now discharging continuously under observation and measurement, detailed measurements of steam and water quantities and pressures being made, and it is estimated that the steam and water now discharging into the atmosphere would generate substantially more than 14,000 kW if harnessed by suitable machines.

GAS TURBINE INSTALLED IN 27 HOURS

The development of the industrial gas turbine in Britain may now be accepted as having reached the stage where its adoption as a prime mover for certain duties has become economical.

That this has been realised is clearly shown by the orders that have been placed with Ruston and Hornsby, Limited, Lincoln, who have in series production a 750/1,000-kW gas turbine, known as the Mark TA, developed during the last four years from their original 750-kW machine, as described in ENGINEERING, vol. 175, page 321 (1953).

One of these machines is to go to Italy, where it will be the first industrial gas turbine to be installed in that country. It is for the Societa Nazionale Metanodotti, an organisation concerned with exploration and drilling for natural gas, large quantities of which have been discovered in recent years. The turbine will use the methane gas from the wells as fuel and will drive an alternator, while the waste heat will be used to provide heat for the buildings.

Eight Mark-TA machines each developing 905 brake horse-power are to be used in the London County Council's sewage works at Beckton. Five will drive blowers to give a flow of 100,000 cub. ft. of air per minute, and the other three will drive generators. The fuel used will be sewage gas. Besides these a machine has been ordered by the Bank of England for operation on CTF 200 coal-tar fuel and a similar machine is to be installed in the works of the Crittall Manufacturing Company, Limited.

The first of the production gas turbines to leave the works of Ruston and Hornsby was one ordered by the Air Ministry in August, 1950. It was of the TA design and is now in operation driving a 3·3-kV alternator. The specification to which it was made called for a machine readily transportable by air and capable of generating power within a few hours of being landed from an aircraft. To make this possible, it was built in three independent sections, each having its own rubber-tyred bogies to facilitate moving into position for assembly.

The three sections are each mounted on their own frame. The gas generator, which is the first unit, consists of an air-inlet bend for supplying air to the 13-stage axial compressor, the compressor, the compressor turbine and the combustion chamber. The second is the power turbine, gearbox, exhaust-outlet duct, and oil reservoir for the turbine, and the third comprises the alternator and exciters.

Assembly of the three sections is comparatively simple. The gas-generator and power-turbine units are connected together by four taper-fitting bolts in the frame and by a ring of bolts which form the joint between the compressor-turbine stator and the intermediate duct. All the electric cables and pipes have been fitted with quick-release plugs and connections. The alternator is attached to the gearbox output shaft by six bolts, and its frame to that of the power turbine by two lugs and mating arms which are held together by two large taper-fitting bolts. The alternator rotor is supported at one end by a pedestal bearing and at the other end by the gearbox output-shaft bearing through a special double-tooth flexible-gear coupling which, in an emergency, will allow the machine to run with as much as $\frac{1}{4}$ in. malalignment between the alternator and power turbine. The complete assembly is supported by seven screw-type jacks, four to the alternator, two to the power turbine and one to the gas generator, which allow the machine to be levelled on ground that is uneven.

This arrangement, together with the flexible coupling, simplifies the task of aligning the turbine and alternator. Transverse and longitudinal levelling pads are provided on each of the frames so that spirit levels can be placed on the respective pads, and the jacks adjusted until both are level, the jacks then being locked.

The time taken to install this first machine was 27 hours including a delay of 7 hours due to the fact that holes had to be drilled in the elbow flange on the site. The air-inlet ducting, filter-house and air-blast oil cooler to be used with the turbine were installed prior to its arrival, and what was previously the bed of a 500-kW Diesel engine was reduced to floor level and a 3-in. plinth prepared. The turbine is bolted down by four foundation bolts at the alternator end and the rest of the machine is supported on the jacks.

After the installation, the fuel and oil lubricating systems were checked and the compressor was given a trial run up to 2,000 r.p.m. As the set behaved satisfactorily it was immediately started up and run at full speed, which corresponds to 1,500 r.p.m. at the gearbox output shaft.

NEW GENERATING PLANT IN 1953

BRITISH ELECTRICITY AUTHORITY ADD 1,413 MW

The accompanying table, which has been prepared by the Chief Engineer's Department of the British Electricity Authority, shows the plant which was added to public power stations in this country during 1953. This represents an additional output capacity of 1,413 MW, compared with 1,539 MW in 1952 and 1,113 MW in 1951.

As will be seen, the additional plant comprised 31 turbo-alternators with an aggregate installed capacity of 1,518 MW and 68 boilers with an aggregate evaporative capacity of 19,725,000 lb. per hour. This plant was installed in 34 stations, eight of which were new. The Authority planned to commission between 1,300 MW and 1,500 MW, so that the actual figure was just above the mean of these figures.

To meet the winter demand the aim each year is to commission the maximum amount of plant by December 31, and as a result of the efforts of the Authority's construction staff, building contractors and manufacturers, some has been installed in advance of its scheduled date of completion.

Power Station*	B.E.A. Division	Turbo-Generator Plant			Boiler Plant			High-Pressure Pipework
		Installed Capacity		Maker	Capacity		Maker	Maker
		No.	Capacity, each, MW.		No.	Lb. per hr. each		
BANKSIDE	London	1	60	British Thomson-Houston	2	375,000	Foster Wheeler	C. A. Parsons
BARKING "C"	London	1	75	British Thomson-Houston	3	405,000	Babcock & Wilcox	Aiton
BATTERSEA "B"	London	1	100	Metropolitan-Vickers	1	425,000	Babcock & Wilcox	Aiton
BOLD "A"	Merseyside and North Wales	1	30	Metropolitan-Vickers	1	300,000	Yarrow	Aiton
BRAEHEAD	South West Scotland	1	50	C. A. Parsons	1	300,000	Babcock & Wilcox	Babcock & Wilcox
BRIGHTON "B"	South Eastern	2	52	Richardsons Westgarth	3	320,000	Babcock & Wilcox	C. A. Parsons
BROMBOROUGH	Merseyside and North Wales	—	—	—	2	300,000	Babcock & Wilcox	Stewarts and Lloyds
BRUNSWICK WHARF	London	1	52·5	Metropolitan-Vickers	2	320,000	Clarke Chapman	C. A. Parsons
CARMARTHEN BAY	South Wales	2	52·5	Metropolitan-Vickers	5	240,000	Babcock & Wilcox	Stewarts and Lloyds
CARRINGTON	North Western	1	60	Metropolitan-Vickers	3	360,000	Babcock & Wilcox	Stewarts and Lloyds
CHADDERTON	North Western	1	60	Metropolitan-Vickers	1	360,000	Simon Carves	Stewarts and Lloyds
CLARENCE DOCK	Merseyside and North Wales	1	51·5	Metropolitan-Vickers	—	—	—	Stewarts and Lloyds
CONNAH'S QUAY	Merseyside and North Wales	1	30	C. A. Parsons	1	300,000	International Combustion	John Thompson
CROYDON "B"	South Eastern	—	—	—	1	320,000	Simon Carves	Aiton
DEPTFORD EAST	London	1	52·5	Metropolitan-Vickers	2	250,000	Foster Wheeler	John Thompson
DONCASTER	Yorkshire	1	30	General Electric	3	180,000	Mitchell	Aiton
EAST YELLAND	South Western	2	30	C. A. Parsons	4	180,000	John Thompson	C. A. Parsons
HUDDERSFIELD	Yorkshire	1	30	General Electric	1	180,000	Bennis	C. A. Parsons
HUNCOAT	North Western	—	—	General Electric	1	305,000	Simon Carves	C. A. Parsons
KEADBY	Yorkshire	1	60	C. A. Parsons	1	550,000	Stirling Boiler Co.	C. A. Parsons
LITTLEBROOK "C"	South Eastern	2	60	C. A. Parsons	3	360,000	International Combustion	C. A. Parsons
NECHELLS "B"	Midlands	1	52·5	C. A. Parsons	4	230,000	International Combustion	Stewarts and Lloyds
NORTH TEES "C"	North Eastern	1	60	C. A. Parsons	3	360,000	Babcock & Wilcox	Babcock & Wilcox
POOLE	Southern	—	—	—	2	300,000	International Combustion	Aiton
ROOSECOTE	North Western	2	30	Metropolitan-Vickers	2	300,000	Yarrow	Aiton
ROTHERHAM	Yorkshire	—	—	—	1	200,000	International Combustion	Stewarts and Lloyds
RYE HOUSE	Eastern	2	32	Rich. Westgarth/C. A. Parsons	2	350,000	Babcock & Wilcox	Stewarts and Lloyds
SKELTON GRANGE	Yorkshire	—	—	—	1	360,000	International Combustion	Aiton
STAYTHORPE	East Midlands	1	60	British Thomson-Houston	2	240,000	Babcock & Wilcox	Aiton
THORNHILL	Yorkshire	—	—	—	2	180,000	Mitchell	Stewarts and Lloyds
USKMOUTH	South Wales	1	60	General Electric	3	360,000	Babcock & Wilcox	Aiton
WALSALL	Midlands	—	—	—	3	180,000	Babcock & Wilcox	Aiton
WEST HAM	London	—	—	—	1	180,000	John Thompson	Aiton
WESTWOOD	North Western	1	30	British Thomson-Houston	1	300,000	Babcock & Wilcox	Stewarts and Lloyds
Totals : 34 stations		31	1,518		68	19,725,000		

* The names in large type are those of new stations, in which plant was commissioned for the first time in 1953. The others are existing stations to which extensions have been made.

INSTITUTION OF ELECTRICAL ENGINEERS

NEW HONORARY MEMBER

The Council of the Institution of Electrical Engineers announce that Mr. Ernest Leete was elected an Honorary Member at their last Council meeting. Mr. Leete was born at Wallington, Surrey, and educated at Uppingham. In 1904, he joined the London Electric Wire Company and Smiths, Limited, becoming, eventually, secretary, managing director, and consultant. He served as chairman of the Cable Makers' Association in 1928.

First elected to the Institution in 1917, he became an ordinary member of Council in 1925 and subsequently served for two other terms. On three separate occasions he served the full period of three years as Honorary Treasurer, and has always taken a keen interest in the Benevolent Fund, for which he served as deputy chairman of the Court of Governors. Mr. Leete was one of the prime movers in the inauguration and development of the "The Chesters" residential estate of the Institution of Electrical Engineers.

FARADAY MEDAL

The Council also announce that the thirty-second award of the Faraday Medal has been made to Mr. Isaac Shoenberg, for his distinguished work in electrical engineering and in particular for the outstanding contributions he has made to the development of high-definition television in this country.

Mr. Shoenberg is a director of Electric and Musical Industries, Limited, and led the team which developed the television system and equipment adopted by the British Broadcasting Corporation in 1936.

PERSONAL

SIR HARRY BROWN, C.M.G., M.B.E., M.I.E.E., chairman of the British General Electric Co. Pty. Ltd., of Australia, has retired at the age of 75. MR. T. E. MORGAN, at present managing director of the company, has been appointed chairman and managing director and MR. A. T. BRIDGE, MR. R. J. DARTON and MR. C. DRABBLE have been elected directors.

SIR JOHN HACKING, M.I.E.E., formerly deputy chairman (operations) British Electricity Authority, has been appointed consultant with Merz and McLellan, 32, Victoria-street, London, S.W.1.

DR. A. H. LECKIE, B.Sc., F.R.I.C., A.M.I.Chem.E., M.Inst.F., formerly head of the steelmaking division of the British Iron and Steel Research Association, has taken up the position of technical officer with the Iron and Steel Board. DR. J. PEARSON, M.Sc., F.R.I.C., is temporarily taking over the duties of head of the steelmaking division, in addition to his present duties as head of the chemistry department. MR. D. LUTHER PHILLIPS, M.Sc., F.R.I.C., F.I.M., retires under the age limit from his position as head of the B.I.S.R.A. South Wales laboratories, on February 10. His successor is MR. S. S. CARLISLE, M.Sc., A.M.I.E.E.

MR. E. D. MAGUIRE has been appointed chairman of Davidson & Co. Ltd., Sirocco Engineering Works, Belfast, consequent upon the retirement of MR. A. A. AGAR, C.B.E.

MR. H. FAULKNER, C.M.G., B.Sc., M.I.E.E., F.I.R.E., has been appointed director of the Telecommunications Engineering and Manufacturing Association.

MR. N. M. NIVEN has been appointed joint managing-director of Drysdale & Co. Ltd., Bon-Accord Works, Yoker, Glasgow, W.4, with the present managing director, MR. JOHN YOUNG, A.R.T.C., M.I.Mech.E.

MR. E. S. WADDINGTON, F.S.E., M.Inst.W., Assoc.I.E.E., has been re-elected vice-chairman of the arc-welding plant section of the British Electrical and Allied Manufacturers' Association.

MR. J. C. WOOD, O.B.E., retires from the position of commercial manager of John Fowler & Co. (Leeds) Ltd., Leeds, 10, after nearly 52 years of service, but retains his seat on the board.

MR. H. G. BELL, M.Sc.(Tech.), M.I.E.E., is to be chief engineer, North Western Electricity Board, British Electricity Authority when MR. O. HOWARTH, M.I.E.E., retires next month.

The United Steel Companies Ltd. announce that MR. E. F. FARRINGTON, formerly senior civil engineer for maintenance, Appleby-Frodingham Steel Co., Scunthorpe, has been made assistant to the chief engineer. MR. R. B. ATKIN has become senior civil engineer for maintenance. On April 1, MR. K. PATERSON, a director and chief engineer of the company will take up the appointment of general manager of the United Steel Structural Co. MR. L. GASKELL, chief electrical engineer will become chief engineer to succeed Mr. Paterson.

MR. W. B. HAUGHAN and MR. C. W. JOHNSON have been appointed directors, and President and vice-president, respectively, of John Laing and Son (Canada), Ltd.

MR. R. A. HALL has left the Fairey Aviation Co. Ltd. to become an independent engineering consultant to the motor-car, aviation and associated industries, from an office in Grand Buildings, Trafalgar-square, London, W.C.2.

DR. C. M. BLOW, F.R.I.C., is joining the board of Precision Rubbers Ltd., Bagworth, Leicestershire, as technical director.

MR. S. F. WISE, until recently purchasing and material-control manager, Baker Perkins Ltd., has joined M. Clayton and Son, Ltd., Bradford, as a director and secretary.

MR. R. J. F. HOWARD, chief engineer, and MR. S. BURR, works manager, have joined the board of Lancashire Dynamo Electronic Products, Ltd., Rugeley, Staffordshire.

MR. A. I. BRAY, B.Sc. (Eng.), A.C.G.I., A.M.I.E.E., has been made engineer-in-charge, television outside broadcasts, B.B.C., London.

MR. F. HOWITT has relinquished the position of technical superintendent and deputy manager of the Northern Aluminium Co.'s foundry and forge, Middlemore-road, Handsworth, Birmingham, on being transferred to the Aluminium Co. of Canada Ltd., Montreal. MR. S. WILDING has been made production manager, MR. D. A. ELLIS, works engineer, and MR. A. R. MARTIN, chief metallurgist.

MR. A. S. FULLARTON, C.A., secretary of Ruddock and Meighan Ltd., Burford House, Harrow View, Wealdstone, has been elected a director.

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BUSINESS CHANGES

THE CAMBRIDGE INSTRUMENT CO., LTD., 13, Grosvenor-place, London, S.W.1, have opened a GLASGOW REPAIR AND SERVICE DEPOT, at 7, Norfolk Court, Norfolk-street, Glasgow, C.5. (Telephone: South 0349.)

The export division of BRITISH PAINTS LTD. is now situated at Crewe House, Curzon-street, London, W.1.

THE OWEN ORGANISATION have acquired the business of CHARLES CLARK and Son Ltd., Wolverhampton and Shrewsbury.

AYLESBURY TURNED PARTS (TRUE SCREWS) LTD., Britannia works, Britannia-street, Aylesbury, Bucks., have now been appointed sole agents in this country for all "Helios" precision-measuring instruments.

MONSANTO CHEMICALS LTD. have formed a new and wholly-owned subsidiary company, MONSANTO PLASTICS LTD., Victoria Station House, Victoria-street, London, S.W.1.

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OBITUARY

We regret to record the deaths of the following: MR. C. F. COGSWELL, A.C.A., secretary of Philips Electrical, Ltd., Century House, Shaftesbury-avenue, London, W.C.2, at his home, Hayes, Kent, on December 28, at the age of 55. MR. R. A. BLAKEBOROUGH, chairman and managing director of J. Blakeborough and Sons, Ltd., Woodhouse Works, Brighouse, Yorkshire on January 3, at the age of 72. MR. H. R. BACKHOUSE, chairman and managing director of Mellor, Bromley & Co., Ltd., Leicester, on January 5, at the age of 59. MR. L. B. COOPER, works manager, Dorman, Long & Co. Ltd., Britannia Works, Middlesbrough.

MODERN TELEVISION EQUIPMENT

COMMERCIAL AND EXPERIMENTAL

The annual exhibition of the Television Society was held this year at King's College, London, W.C.2, on January 7, 8 and 9. Much of the latest television equipment and some experimental apparatus were displayed on the 38 stands.

There were three examples of large-screen projection, the largest being made for a cinema screen, and exhibited by Cinema-Television, Limited; only the control desk and projector unit were shown. This equipment will give a picture comparable in brightness with the average film and with a high contrast ratio. A smaller unit is that shown by Nera of England, Limited, with a screen 4 ft. by 3 ft. The whole equipment is contained in one cabinet which is mounted on casters for mobility. When not in use, the screen and reflecting mirrors fold back into the cabinet; lowering the screen automatically switches off the set. The third projector, made by Ferranti, Limited, had a screen of 17¼ in. by 13 in.

In order to avoid the great contrast between the bright picture and the dark surround of the cabinet, the Ferguson Radio Corporation, Limited, have introduced their "Halolight." This is an illuminated surround of controllable brilliance, made of a cold-cathode fluorescent tube covered by a translucent material. For viewing comfort, the brightness of the surround lies between ¼ and $\frac{1}{10}$ of the average picture brilliance.

Several exhibitors had displays of measuring instruments for use during the manufacture and installation of television equipment. Among them, Belling and Lee, Limited, were showing a device which, by splitting the picture on the screen, can give a direct comparison between two aerials, each of which would be supplying half the picture. Also on their stand was an instrument for measuring simultaneously the amplitude and quality of the signal.

Interference, particularly from motor-car ignition systems, is always one of the difficulties of television. The British Radio Equipment Manufacturers Association were showing the effect of fitting suppressors to an engine, by comparing the pick-up from suppressed and unsuppressed systems. In conjunction with this, the General Electric Company, Limited, were showing a Grey Spot limiter by which the interference spots could be toned to any shade between white and black, allowing them to fade into the picture background.

E. K. Cole, Limited, were displaying one of their amplifier-converter units which are designed to extend the range of reception without the need of land lines. Housed in a single rack, some 6 ft. high, this equipment receives both sound and vision, and then re-transmits them after changing both frequency and polarisation. This conversion avoids interference with the original transmission.

Illustrations and some of the apparatus used for the Coronation broadcast to Europe were on the stand of Standard Telephones and Cables, Limited. British Insulated Callender's Cables, Limited, exhibited a number of products, which included their polypole couplers and multi-unit cables such as are used with television cameras and mobile units, and also their new "quad" cables designed for television relay services.

Experimental and development work was demonstrated by several exhibitors, including the Post Office Research department.

NEW ROLLING STOCK FOR BRITISH RAILWAYS

Steel Supplies Permit Greater Output

British Railways plans for new rolling stock in 1954 include the provision of 2,750 passenger-train vehicles, 53,000 freight wagons and 325 locomotives. This planned output is two and a half times the number of passenger-train vehicles built in 1953, 36 per cent. more freight wagons and 50 per cent. more locomotives. The programme reflects the improved steel supply position and the intention of the British Transport Commission to concentrate on replacing obsolete vehicles, particularly passenger coaches, with all speed.

Of the 325 locomotives to be built, 254 will be of the new standard designs, including 40 Class 9 heavy freight engines, the first of this type to be built and the most powerful in the standard range. There will also be 14 Diesel-mechanical shunters, and 50 steam tank engines for shunting.

All the passenger vehicles and brake vans will be of the new standard all-steel design ; 1,820 will be passenger-carrying vehicles and the remaining 930 will be brake-vans, horse boxes, fish vans, and other vans for running in passenger trains. British Railways shops will build 2,180 vehicles and the remainder will be built by contractors.

New wagons will include 3,100 for carrying loads of steel weighing up to 50 tons, and various wagons of special design for carrying loads of 21 to 65 tons. Of the total of 53,000 new wagons, 20,000 will be built in British Railways shops and the remainder by contractors.

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CHANNEL AIR-FERRY TRAFFIC

More Vehicles Carried

In 1953, Silver City Airways flew more vehicles and passengers across the English Channel than in the five previous years added together ; 96,625 passengers and 39,041 vehicles were flown, compared with 28,836 passengers and 10,941 vehicles in 1952. The 1953 vehicle traffic was made up of 24,063 cars (6,896 in 1952), 8,227 motor cycles (2,203), and 6,751 pedal cycles (1,842). More than 14,700 cross-Channel flights were made and in August, when the aircraft were making as many as 170 crossings a day, the traffic carried exceeded the total for the whole of 1952.

As well as operating the Channel air ferry, the company's Bristol 170 aircraft maintained the " Berlin Airlift " and general charter operations. In all, the company flew 1,583,842 miles, compared with 965,385 in 1952. A total of 18,792 individual flights were made (8,776 in 1952) and each aircraft averaged 3,200 landings and take-offs per annum.

Although the average stage length of each flight fell from 110 to 84 miles, aircraft utilisation in the air-ferry division was exactly doubled in 1953. Of the total flying time of 11,650 hours, approximately 6,220 were spent on air-ferry operations. In all operations, the total revenue load in terms of vehicles and general freight increased from 20,580 to 48,000 short tons and revenue ton-miles increased from 2·4 million to 4·3 million.

Freight operations on the Berlin Airlift, between Berlin and Hamburg, increased by 20 per cent. Altogether, 3,294 flights were made during 1953 compared with the 2,625 carried out in 1952.

NICKEL INDUSTRY IN 1953

THE END OF RESTRICTIONS

Preliminary figures show that during 1953 the production of nickel in the whole world, excepting the U.S.S.R. and her satellite countries, was about 340 million lb., an increase of about 20 million lb. over the 1952 total and of 50 million lb. over that for 1951.

The Canadian output of nickel during 1953, according to data given in the course of a year-end review by Dr. J. F. Thompson, chairman of the board of directors of the International Nickel Co. of Canada, Limited, was about 285 million lb., or 85 per cent. of the total production of the world as defined above. The Government restrictions on the uses of nickel, which had been in force for several years, were relaxed substantially in 1953. In October last year, Canada removed all restrictions on the purchase and use of nickel. In the United Kingdom, all similar controls on the metal were raised as from November 6, and in the United States analogous steps were taken which became effective on November 1.

As has been the case for some years past, the steel industries of the United Kingdom, Canada and the United States were the largest consumers of nickel in 1953, the metal being used for the production of stainless steels, engineering alloy steels and heat-resisting materials for gas turbines.

The production of Monel and similar high-nickel non-ferrous metal alloys has continued to expand, and, since the relaxation of controls, manufacturers of nickel-silver are returning to the production of the 18-per cent. nickel-containing grades of this copper-nickel-zinc alloy. Previously the percentage of nickel allowed, even in permitted uses of the alloy, had been radically reduced and many applications entirely prohibited. Moreover, the demands for the 10 per cent. and 30 per cent. nickel grades of the cupro-nickel alloys have shown increases in recent months, while a significant quantity of nickel was utilised during 1953 for the production of nickel-chromium alloy castings for use in the construction of heat-treating furnace equipments.

The abrasion-resisting and corrosion-resisting nickel-chromium and other alloy cast irons continue to find many applications in industry, while the magnetostrictive property of nickel has been applied in several new fields. These include an electronic machine tool capable of cutting intricate shapes in very hard materials, oil-well drill bits which markedly increase drilling rates in hard rock, and equipment for hunting whales at sea.

TECHNICAL TRAINING IN THE MOTOR INDUSTRY

DISTRIBUTION AND REPAIR

A residential training course designed to give to young men the necessary technical, administrative and commercial preparation for a career in the motor industry is to begin at Loughborough College of Technology next September. The course is intended less for those planning to enter one of the large manufacturing concerns than for prospective members of the distributive, retail and repairing sections of the industry.

The value of establishing a training scheme of this kind has long been appreciated, and although it is not intended that the majority of successful students should enter manufacturing firms, such firms will profit indirectly from the plan. An increase in the number of qualified executives within the retail and distributive branches will enable the industry as a whole to function more efficiently. Furthermore, the existence of training facilities at the Loughborough College of Technology has relieved the industry of the financial burden of building its own establishment.

The minimum age of entry for the course is 18 and there are to be three scholarship awards, each of £150 a year. Students completing the four-year training and satisfying the examiners may obtain a pass diploma of the College which will exempt them from the Associate Membership Examination of the Institute of the Motor Industry.

It was in his presidential address to the Institute on January 7 that Mr. Stanley S. Dawes announced the inauguration of the motor industry course. He said that it would be based on an automobile diploma course, into which would be introduced the subjects of sales and office administration, accounting and costing, management and law relating to the industry. A detailed syllabus covering these studies and a timetable is being prepared.

Entrance will be based on the General Certificate of Education or an equivalent examination, and all applications must be received before the end of May. The cost for each student, at existing rates of tuition and including residence and certain additions, will be between £250 and £300 a year. As an encouragement the Institute will contribute £150 per annum towards this sum for two candidates and a further scholarship award of the same figure has been promised by Sir George Kenning, a vice-president of the Institute and a pioneer of the industry.

In the initial stages, the course will accommodate between 20 and 30 students, and during the fourth year from 80 to 120 students will be in residence, 20 or 30 of whom will be completing the course. Thereafter, the number of graduates will depend on the support of the industry.

Mr. Dawes hoped that the whole motor industry would support the scheme and that opportunities would be provided for students to gain experience in works during the long vacations. He suggested that the industry should recognise the Residential Diploma Course as an integral part of its training programme and that it should fully accept the qualifications awarded. The course would not conflict with the training schemes already provided by many companies, which served a different purpose.

An announcement was made that the Council of the Institute had granted a petition, submitted by members resident in South Africa, for the establishment of the Institute's activities in that country. This has been done with the full support of the South African Motor Industry Employers' Association, with whose co-operation, it is hoped, theoretical courses under the South African Apprenticeship Act may be related to training courses for the Associate Membership of the Institute.

BRITISH ELECTRICAL POWER CONVENTION, 1954

Development of Home and Overseas Markets

The development of the home and overseas markets for electricity and electrical appliances is to be the theme of the sixth British Electrical Power Convention, which is to be held at Eastbourne from Monday, June 14, to Friday, June 18. Delegates from 37 electrical organisations will attend under the presidency of Mr. J. R. Beard, who will deliver an address at the formal inaugural meeting on Tuesday morning, June 15.

According to preliminary arrangements, which are subject to alteration, at subsequent meetings papers on "The Market for Electrical Appliances and the Interdependence of Home and Export Trade," will be presented by Sir George Wilson; on "Modern Lighting for Industry, Commerce and the Home," by Mr. W. J. Jones; on "Electricity in the Modern Home," by Dame Caroline Haslett; on "The Development of the Domestic Electricity Load at Home and Overseas," by Mr. D. Bellamy; and on "The Comparison of Installation Practice at Home and Overseas," by Mr. S. L. M. Barlow. In addition, there will be an Electrical Forum at which questions will be answered by a panel of experts.

Associated with the Convention will be an electrical exhibition which will be held in the Winter Gardens Grounds.

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HYDRO-ELECTRIC WORK IN TASMANIA

19-ft. Prestressed Concrete Pipe

Further development of hydro-electric power on the Derwent River is being undertaken by the Hydro-Electric Commission, Tasmania. The Tarraleah power station on the Nive River has been completed, with six 21,000-h.p. Pelton wheels operating under a static head of 980 ft. On the opposite bank of the same river the Tungatinah power station now has three 35,000-h.p. Francis turbines operating under a static head of 1,005 ft. The fourth and fifth units are expected to be in service within the next twelve months.

The next development will be the diversion of the water from these two stations, by a gravity dam 70 ft. high on the Derwent River, below its confluence with the Nive River. The water will pass through a lined tunnel about a mile long and then through 4,600 ft. of prestressed concrete pipe 19 ft. in diameter to penstocks that will lead to three 25,000-h.p. Francis turbines.

The construction of the 19-ft. concrete pipe will be the largest venture in prestressed concrete so far undertaken in Australia and the Commission is now inviting tenders for either the design and partial supervision of construction or the design and construction of the pipe. All associated civil works will be undertaken by the Commission. It is planned to have this new station – Wayatinah "B" – in operation by the middle of 1956.

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ULTRA-SENSITIVE MECHANICAL COMPARATOR

The Mikrokator ultra-sensitive mechanical comparator, described in the article on page 23 in the issue of January 1, is made by Aktiebolaget C. E. Johansson, Eskilstuna, Sweden, for whom C. E. Johansson, Ltd., deal with sales and service in this country.

British Standards

FROM DESIGN TO PRODUCTION

The following publications have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2, Park-street, London, W.1, at the price given after each title.

Engineering Drawing Practice.
(10*s.* 6*d.*, post free.)

To unify existing systems of indicating dimensions and tolerances on drawings, the British Standards Institution have published B.S.308 : 1953. This Standard is also concerned with the principle of geometrical tolerances, for which, it is hoped, a wide acceptance will be secured. It supersedes B.S. 308 : 1943 and is divided into two sections. The first is devoted to general drawing practices; the second, based largely on the Stationery Office publication *Dimensional Analysis of Engineering Designs*, covers dimensions and tolerances. The importance of the latter section is underlined by the increasing distribution of engineering work in the form of subcontracts and the necessity for components made by different firms to fit properly.

It is almost equally important in drawings to avoid the specification of production standards finer than those required. Little is gained also by setting limits outside the scope of the tools available. Because tolerances have been indicated thoughtlessly in drawings, inspectors have occasionally rejected work quite suitable for its purpose.

The technical committee responsible for this Standard state that customary dimensioning and tolerancing, however well applied, will not necessarily ensure that components assemble or function correctly. A section on this subject was therefore introduced, to promote a reasonably uniform practice in the expression of drawing dimensions and tolerances, and to provide means of tolerancing such geometrical characteristics as straightness, flatness, parallelism, squareness, angularity, concentricity and position. A geometrical tolerance is defined as the maximum permissible overall variation of form or position from that shown on the drawing. It is thus the width or diameter of a tolerance zone within which the surface, or the middle plane or axis of the feature, is to lie. It represents the full indicator movement in cases where indicator tests are possible. Roundness, for example, can only be toleranced in terms of a practical method of checking, such as the use of a V-block and dial indicator. The near-circular, lobed figures illustrated in the Standard present to a pair of calipers a constant diameter in whatever position they are applied. To avoid inaccuracies of this kind, the drawing should show the maximum indicator movement permitted in a given test.

The Standard discusses the conception of "maximum metal condition" (M.M.C.) which is related to the fit of one part in another. It is suggested that the abbreviation M.M.C. be added to the tolerance notes whenever a wide dimensional tolerance in the mating parts might permit a relaxation of geometrical tolerance without endangering free assembly. Functional dimensions should be expressed directly on the drawing and never left to be inferred; but no more dimensions should be given than are necessary to define the component.

There can be no hard and fast rule for determining the extent of tolerancing. Such considerations as the type of production (whether experimental or in large quantity), the degree of interchangeability required, the nature and quality of the workshop equipment, and the experience of inspectors and craftsmen must be taken into account. But whatever the rival claims of speed and economy, the main object is the production of a satisfactory finished article.

In the general section of the Standard a wide range of drawing office practices are recommended which, if accepted, will ensure uniformity of product and the ready understanding of alien drawings. At present, for example, parts and drawing lists are located by some firms on the drawing and by others on separate translucent sheets. Although it is realised that certain products require a special approach, it is considered necessary that an attempt be made to limit the number of systems used. A reduction in the number of drawing sheet sizes available is also proposed and it is hoped that, although cabinets and drawing boards have been designed to accommodate existing sizes, it will not prove uneconomical to adopt the standard range described.

The practices described in the Standard include the use of a grid system to enable items in a large drawing to be quickly located; the substitution of conventional symbols for certain common features such as bearings; the relation of a structural member to its assembly by means of a small chain-dotted key plan, and the observance of a colour code for denoting materials. Wherever possible the main view of a part should have the same orientation as that shown in the assembly drawing.

The method of sectioning is described, and exceptions to the rule, which include ribs, shafts, keys and bolts, are listed. Examples of lines suitable for use in drawings are illustrated and a table of general engineering terms and their abbreviations is provided. Dual scales are recommended for detailing framed structures. In this method the centre-lines are drawn to a small scale and the junctions of the members, which are shown discontinuously, to a much larger scale.

No preference is expressed between first and third angle projection and no relaxation of the principle of drawing to scale is indicated. In this respect, the Standard makes no concession to the simplified practices described in a recently-published American book, *Simplified Drafting Practice: A Modern Approach to Industrial Drafting*, which was reviewed in our leading article of November 13, 1953. Nevertheless, the establishing of conventions and widely accepted practices is a step in the same direction and the publication of this Standard will, it is hoped, enable drawings to be produced with greater speed and with clearer instructions to the shops.

Steel Wire for Springs (Rust, Acid and Heat Resisting)
(2*s.* 6*d.*, post free.)

A new specification, B.S.2056, dealing with rust, acid and heat-resisting wire for springs has been published. It covers the same types of steel as does B.S.1554 but specifies the requirements for such wire when it is to be used in the form of springs. The publication has been prepared at the request of the Coil Spring Federation.

Chemical Stoneware (Methods of Testing).
(3*s.*, post free.)

Fifteen years after the first publication of B.S.784, which is concerned with the testing of chemical stoneware, a revision has been prepared and issued. During the period which has elapsed since the appearance of the last edition, certain of the tests specified have been found to be of academic interest only and others have been superseded by newer tests. The new edition gives particulars of methods for determining the resistance to compression, the transverse strength, the resistance to abrasion, the true and the apparent specific gravity, the apparent porosity and water absorption, the thermal expansion, the resistance to thermal disruption, the acid-soluble iron and the resistance to acid. Full details of the apparatus and test-pieces needed and the procedure are given for all the test methods.

Ropes (Made from Coir, Hemp, Manila and Sisal).
(10*s.*, post free.)

A new specification, B.S.2052, covers ropes made from coir, hemp, manila and sisal; it has been prepared in collaboration with the Joint Equipment Standardisation Committee of the Ministry of Defence, and is intended to provide a range of ropes which will meet both Government and commercial requirements. It supersedes B.S.431 : 1946, which dealt with manila ropes for general purposes, and B.S.908 : 1946, concerned with sisal ropes for general purposes. The standard provides for three-strand, four-strand and nine-strand sisal and manila ropes and three-strand coir and Italian-hemp ropes. The ropes are available plain or hawser-laid for three-strand types, shroud-laid for four-strand types and cable-laid for nine-strand types. In accordance with accepted trade practice, the sizes of the ropes are based on their circumference and not on their diameter. The specification deals with the quality of materials; the construction of the rope; its length, weight, breaking load and finish, and packing methods for transport. Methods of test for verifying compliance with the requirements are included.

Spring Washers. (Phosphor Bronze for General Engineering Purposes) (2*s.* 6*d.*, post free.)

A new standard, B.S. 2061, covers phosphor bronze spring washers and supplements that for steel washers, B.S. 1802. Three types, namely single-coil – of square and rectangular sections – and double-coil, are specified, and the requirements stipulated relate to composition of the alloy, tolerances and dimensions, hardness and test for permanent set.

Book Reviews

Graphs of the Compton Energy-Angle Relationship and the Klein-Nishina Formula from 10 Kev to 500 Mev. By ANN T. NELMS. National Bureau of Standards Circular No. 542. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (55 cents.)

This circular originated in a request from the N.B.S. Radiation Physics Laboratory for tabulations of the Compton Energy-Angle relationships and differential and integral Klein-Nishina cross section for unpolarised gamma rays. Previously published data were found to cover too limited an energy range of the primary radiation and were presented in forms incapable of yielding accurate interpolated values of the cross section. To remedy these defects the data here presented are expressed in currently adopted units and exhibited in graphical form with an extension of the energy range to 500 Mev.

The decision to use graphs instead of tables was taken largely on account of the convenience and accuracy of two-way graphical interpolation. All calculations were carried to 4 significant figures and precautions were taken to locate each point on the graphs with an accuracy of 1 per cent. Careful checks for smoothness were instituted to ensure that all points along the curves should be equally accurate. To obtain maximum accuracy for interpolated values the type of plot is important. For this reason different kinds of plots are provided for various initial energies and in various ranges of the same energy, each section having the best plot for ease of interpolation. Examples given in the introduction indicate a possible accuracy of interpolation well within the 2 per cent. claimed. In general, each group of graphs is preceded by a "picture" graph displaying the complete range and general shape of the curves in the family but not capable of yielding accurate values. The first section, entitled Compton energy-angle relationship, contains two groups of graphs: the first of scattered photon energy versus angle and the second of recoil electron energy versus angle. Under the heading Differential Klein-Nishina cross section per electron are included five groups of graphs exhibiting photon wavelength distribution, angular distribution of the scattered radiation, angular distribution of the recoil electrons, photon energy distribution and electron energy distribution while the final pair of graphs relate to the integral Klein-Nishina cross section per electron.

Workers in various branches of Radiation Physics will benefit from the careful thought and considerable labour that have gone into the preparation of the originals of these graphs and from the uniformly high standard of the reproductions that have been made from them.

Applied Thermodynamics. By DR. A. C. WALSHAW. Second edition. *Blackie and Son, Limited*, 16-18, *King William IV-street, Charing Cross, London, W.C.*2; and *Stanhope-street, Glasgow*. (40*s.* net.)

Among the many text-books on thermodynamics now available, there are few that can be so confidently recommended as the present volume to engineering students who already have some acquaintance with the subject as well as a reasonable mathematical knowledge. It covers the whole field of heat engines in a systematic manner by grouping its subject-matter into four sections, of which the first and longest deals with general thermodynamical principles and also includes chapters on combustion, flow through nozzles and heat transmission. Among its features, the practical advantages of taking the mol, instead of the pound, as a unit in calculations concerning combustion and gas mixtures are emphasised, and the student is also explicitly warned against the common error, shared apparently by certain teachers, of thinking that the theoretical work of polytropic expansion or compression is represented by the area of the theoretical PV diagram depicting the process. The second section is concerned with steam plant, including boilers, condensers, engines, turbines, reheating and feed heating. Internal-combustion engines form the subject of the third section, with chapters on thermodynamic cycles, carburation, supercharging and combustion processes. Gas turbines have a long and informative chapter to themselves in which their special features, including blading, are discussed, as well as the principle of the ram-jet or athodyd. The last section deals with compressors and refrigerating plant and includes a brief explanation of the heat pump. The text contains a large number of fully worked-out examples for the benefit of students, and there are, in addition, a total of 274 questions at the end of chapters, with answers at the end of the book.

The treatment throughout is essentially of a theoretical character, the illustrations of actual machines and apparatus being limited to the minimum required for explaining the principles of their action. The descriptive matter is always informative and practical. The author, who is a member of the Professorial Staff of the Royal Naval College at Greenwich, is to be congratulated on his adherence, throughout, to the ordinary system of units in which English-speaking engineers are accustomed to think and calculate, thus ignoring academic units such as "C.H.U." "slugs" and "poundals." For the assistance of those students who might possibly get into difficulties over the dual meaning of the word "pound" in engineering, he has adopted the simple plan of printing the word as "lb." when it refers to mass, and as "Lb." when it means a force; a distinction which fully meets the case without causing annoyance to adult readers, even if they notice it at all. Another and most useful device, not only for students, is a simple and foolproof way of converting units in arithmetical calculations. The method is to write any unit concerned as the numerator of a fraction having its equivalent in other units as the denominator, or vice versa. Each of such fractions, of course, has the value of unity, so that the expression to be converted can be multiplied by any number of them without altering its value. Before doing any multiplication, however, as much cancellation as possible, both of the literal and the numerical components of the fractions, is carried out with the result that the original expression is quickly and surely brought to the units required.

There is little or nothing that calls for criticism in this excellent text-book, though it may be mentioned that the use of the symbol n as signifying the inverse of the expansion ratio in connection with an indicator diagram (p. 250) may cause difficulty to the student, as the only meaning attributed to n in the list of symbols is the index of the expansion curve

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TRADE PUBLICATIONS

Induction Motors for Loom Drives. A pamphlet issued by the English Electric Co., Ltd., Stafford, gives details of the small induction motors they manufacture for loom drives.

Transportable Wireless Station. A leaflet issued by the Automatic Telephone & Electric Co., Ltd., Strowger House, Arundel-street, London, W.C.2, describes a transportable wireless station. The transmitter is a wide-band V.H.F. unit with an output power of 30 to 50 watts in the frequency range of 50 to 100 megacycles. The receiver is designed to work in conjunction with 3 or 12-channel carrier equipment up to 60 kilocycles. All units are suitable for tropical use.

Excavating, Handling and Concreting Equipment. Ransomes and Rapier, Ltd., Ipswich, have sent us a brochure illustrating the Rapier 424, ⅜-cub. yd. excavator, which is designed for use as a shovel, drag-shovel, or skimmer. By changing the boom this versatile machine may also be used as a dragline, grab, crane or pile-driver. We have also received a leaflet illustrating some of the firm's concrete batching plants, mixers, pumps, etc.

New Photographic Developer. A leaflet giving particulars of a new photographic developer, to which the registered trade name Phenidone has been applied, has been issued by Ilford, Ltd., Ilford, London. It is recommended for use in place of metol in any existing metol-hydroquinone developer, but much less Phenidone is required. Packed developers and solutions containing it are available and can be used for plates, films and papers. The leaflet clearly explains its many important advantages.

Specialised River and Sea-craft. We have received from the Fairmile Construction Co., Ltd., Cobham, Surrey, a loose-leaf catalogue illustrating the types of barges, tugs, fast patrol-boats, ferries, pontoons, etc., which they build with steel or aluminium-alloy hulls.

Contactor Starter. The Belmos Co., Ltd., Bellshill, Lanarkshire, have issued a leaflet describing their automatic direct-on contactor starter, Type VO.30. It is suitable for use with supplies at up to 650 volts alternating current and with motors up to 15 h.p. The contactors are enclosed in dust proof sheet-metal cases for wall mounting.

Marking Machines. Funditor, Ltd., 3, Woodbridge-street, London, E.C.1, have sent us a copy of their newly published "Marking Machine Manual." It gives details of these machines and their accessories, which are suitable for marking metal, plastic, glass and wooden components.

Calendar. A monthly tear-off wall calendar containing coloured drawings illustrating in a light-hearted manner the "secrets" of their success has been issued by Turner Brothers (B'ham) Ltd., Galvanic Works, Cliveland-street, Birmingham 19.

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BOOKS RECEIVED

The Determination of Crystal Structures. By DR. H. LIPSON and DR. W. COCHRAN. *G. Bell and Sons, Limited, York House, Portugal-street, London. W.C.*2. [50*s.* net.]

Engineering Electronics. By PROFESSORS GEORGE E. HAPPELL and WILFRED M. HESSELBERTH. *McGraw-Hill Book Company Incorporated*, 330, *West* 42*nd-street, New York* 36, *U.S.A.* [7.50 dols.]; and *McGraw-Hill Publishing Company, Limited*, 95, *Farringdon-street, London, E.C.*4. [Price 60*s.*]

Actions éoliennes. Phénomènes d'évaporation et d'hydrologie superficielles dans les régions arides. *Centre National de la Recherche Scientifique, Service de Publication*, 45, *Rue d'Ulm, Paris* (5*e*). [2,500 francs.]

Railway Materials Handbook. *The United Steel Companies, Limited*, 17, *Westbourne-road, Sheffield*, 10. [21*s.*]

Manchester Chamber of Commerce Directory, 1954. *Manchester Chamber of Commerce, Ship Canal House, King-street, Manchester*, 2. [10*s.*]

Wade's Tables. Pocket edition, 1953. Overhead electrical transmission lines, strength of wooden poles, etc. *Gabriel, Wade and English, Limited, Southern Chambers, Waltham-street, Hull.* [5*s.*]

Jane's All the World's Aircraft, 1953-54. Forty-fourth year of issue. Compiled and edited by LEONARD T. BRIDGEMAN. *Sampson Low, Marston and Company, Limited*, 25, *Gilbert-street, London, W.*1 (4 guineas net.)

Instrumentation and Control of Mill Furnaces. By members of the Instruments Sub-Committee of the Plant Engineering Division. *The British Iron and Steel Research Association*, 11, *Park-lane, London, W.*1. (5*s.*)

Fully Supported Aluminium Roof Covering. *The Aluminium Development Association*, 33, *Grosvenor-street, London, W.*1. (2*s.* 6*d.*)

Gears for Small Mechanisms. By W. O. DAVIS. *N.A.G. Press, Limited*, 226, *Latymer-court, London, W.*6. (25*s.* net.)

Étude de la Lubrification et Calcul des Paliers. By LUCIEN LELOUP. *Dunod*, 92, *Rue Bonaparte, Paris* (6*e*). [2,100 francs.]

Traité Théorique et Pratique des Engrenages. By PROFESSOR G. HENRIOT. Vol. I. Théorie et Technologie. Second edition. *Dunod*, 92, *Rue Bonaparte, Paris* (6*e*). [3,500 francs.]

Les Applications Pratique des Rayons Infrarouges. By MAURICE DÉRIBÉRÉ. Third edition. *Dunod*, 92, *Rue Bonaparte, Paris* (6*e*).

Engineering Metallurgy. By PROFESSOR BRADLEY STOUGHTON, ALLISON BUTTS and ARDREY M. BOUNDS. Fourth edition. *McGraw-Hill Book Company, Incorporated*, 330, *West* 42*nd-street, New York* 36, *U.S.A.* [7.50 dols]; and *Chapman and Hall, Limited*, 37, *Essex-street, London, W.C.*2. [53*s.* 6*d.*]

The Engineering Outlook—2

THE MANPOWER SITUATION

WAGES AND COSTS

THE importance of making the most effective use of manpower is as important in the United Kingdom to-day as it has been at any time since the war. It is true that, with the reduction in the volume of armament production, the nation's labour resources are not quite at such full stretch as in 1951, but the number of unemployed in October, 1953, was only about 50,000 higher than in October, 1952.* The need to have every available workman at work and employed to the best advantage is essential both to meet the immediate need for increased exports and to counteract the effects of an ageing population. As Sir Godfrey Ince, Permanent Secretary to the Ministry of Labour and National Service, pointed out to the Manchester Statistical Society in November, between 1953 and 1960 the number of workpeople aged between 20 and 40 will have declined by 6 per cent., while those between 50 and 60 will have increased by 20 per cent. The total working population will thus continue to grow, but the demands made on it for increasing production will grow more than proportionately, for, as the number of elderly non-workers grows, the others will have to produce more to support them. The Government have lately given some attention to the problem of retaining older persons in industry, and the report of the National Advisory Committee on the Employment of Older Men and Women, published in October, which recommended that older people could and should remain at work beyond conventional retiring ages, should serve as a basis for further action.

The imperative need for high productivity has long been recognised. American practice has been closely studied, and large sums have been devoted to seeing that knowledge of the latest techniques is widely disseminated throughout industry. Nevertheless, the accumulated knowledge is not always put to the fullest practical use. Employers tend to postpone the purchase of plant and machinery when markets deteriorate, although higher productivity is then more essential than ever. Workpeople tend to prefer security of employment to new machines which may displace them, and press for higher wages regardless of whether these can be justified by increased productivity. At present, in addition to the claim of the engineering unions for a 15 per cent. increase, large claims by the transport, building and miners' unions are outstanding. These, if granted, and not matched by very large increases in productivity, would add substantially to the costs of manufacturing industry at a time when it is essential to counter foreign competition.

In no industry are the related questions of manpower, productivity and costs more vital than in engineering, since the only solution to the United Kingdom balance of payments difficulties lies in an increase in exports of engineering products. This means that the engineering labour force must expand, but whereas the total numbers engaged in civil employment rose by 151,000 in the year to September 30, 1953, reaching 22·3 millions, the total number employed in the industries manufacturing metals and metal products, excluding vehicles, actually fell slightly, by about 20,000. The number employed in vehicle manufacture increased by 54,000 but this was related to increased production for home rather than export.

The distribution of manpower by main industry groups is shown in the diagrams. The fall in employment affected many of the staple branches of engineering, for example, iron foundries, non-ferrous metal processing, the manufacture of agricultural machinery, stationary engines, textile machinery, electrical machinery and apparatus, and miscellaneous mechanical engineering products. All of these have lost ground in the export markets. There has been some improvement in exports since September and these industries may have absorbed more labour, but they are still far from reaching their export potential. The numbers employed in the various sections of engineering are given in Table I, taken from the *Ministry of Labour Gazette*.

* The latest manpower statistics issued by the Ministry of Labour are summarised elsewhere in this issue.

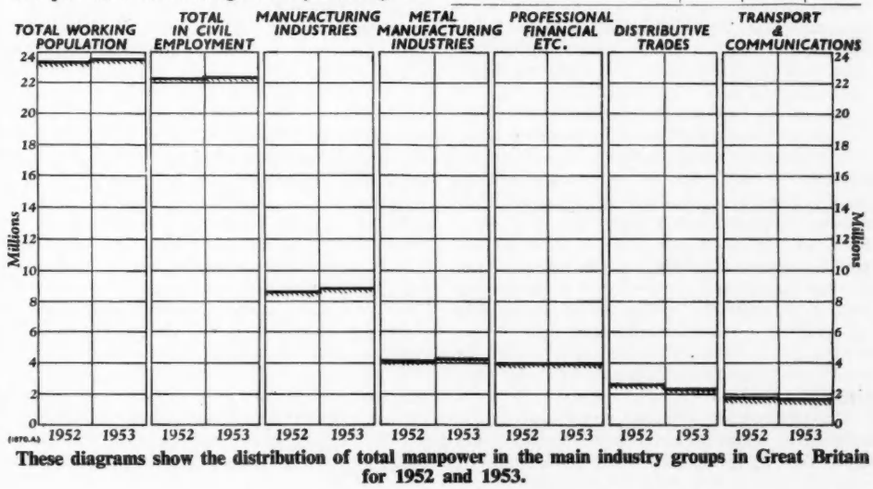
WAGES IN ENGINEERING

This is the background which the Engineering and Allied Employers' National Federation had to consider when they rejected the claim put forward by the Confederation of Shipbuilding and Engineering Unions for a 15 per cent. increase in wages. This claim, which covers about 3 million workers, would give the skilled tradesmen an additional £1 and the unskilled an additional 17*s.* 6*d.* per week. It would add £125 millions to the industry's wages bill. The employers pointed out, in a statement issued in October, that in the year ended May, 1953 the volume of orders had fallen off by 25 per cent., following a decline of 8 per cent. in the previous 12 months.

In pressing their claim, the unions certainly could not seek justification in the advance in the cost of living. It was put forward within five months of the granting of a rise of 7*s.* 4*d.* a week in November, 1952; and, whereas the index of the cost of living had risen by only 4·4 per cent. the average weekly earnings of male workers in engineering had risen by 6·4 per cent. A comparison is made between the trends of wage rates and the cost of living in the graph opposite. Each year since the war the rising cost of living has been cited as the principal justification for wage claims. In 1953, the unions, while still apparently following the habit of annual wage claims, have had to seek other justifications; this time they made a show of relating them to increased productivity. There was little material change in the situation since the previous wage claim which could be cited

TABLE I.—*Great Britain: Employment in the Metal Manufacturing and Engineering Industries. (Thousands.)*

—	Sept., 1951.	Sept., 1952.	Sept., 1953.
Metal Manufacture	536·5	556·2	542·9
Blast furnaces	20·3	20·2	23·0
Iron and steel melting, rolling, etc.	213·4	216·7	219·7
Iron foundries	118·6	127·8	121·6
Tinplate manufacture	17·4	18·9	13·1
Steel sheet manufacture	19·2	18·1	19·3
Iron and steel tubes (incl. melting and rolling in integrated works)	43·5	46·7	45·1
Non-ferrous metals, smelting, rolling, etc.	104·1	107·8	101·1
Engineering, Shipbuilding and Electrical Goods	1,912·5	1,896·9	1,897·3
Shipbuilding and ship repairing	203·1	206·0	210·2
Marine engineering	74·8	73·6	76·4
Agricultural machinery (excl. tractors)	42·8	42·0	39·3
Boilers and boiler house plant	26·0	28·9	30·4
Machine tools	81·6	97·3	98·0
Stationary engines	27·2	26·3	24·2
Textile machinery and accessories	68·9	71·1	66·7
Ordnance and small arms	45·7	51·1	60·5
Constructional engineering	74·4	77·9	79·9
Other non-electrical engineering	683·7	637·1	612·4
Electrical machinery	178·8	186·2	175·0
Electric wires and cables	64·2	63·4	58·9
Telegraph and telephone apparatus	49·5	53·5	52·4
Wireless apparatus (excl. valves) and gramophones	98·8	96·8	111·5
Wireless valves and electric lamps	42·7	41·2	38·4
Batteries and accumulators	20·7	19·1	19·6
Other electrical goods	129·6	125·4	143·5
Vehicles	976·8	1,051·1	1,105·7
Manufacture of motor vehicles and bicycles	306·9	296·3	297·1
Motor repairers and garages	231·1	257·7	256·7
Manufacture and repair of aircraft	165·2	200·3	224·9
Manufacture of parts and accessories for motor vehicles and aircraft	106·1	126·4	146·2
Railway locomotive shops	59·5	58·8	61·8
Other locomotive manufacture	22·2	25·6	25·6
Manufacture and repair of railway carriages and wagons and trams	77·1	78·1	85·5
Carts, perambulators, etc.	8·7	7·9	7·9
Metal Goods not elsewhere specified	503·1	493·0	482·5
Tools and cutlery	55·1	50·1	44·4
Bolts, nuts, screws, rivets, nails, etc.	38·1	42·1	38·0
Iron and steel forgings, not elsewhere specified	36·2	39·7	39·1
Wire and wire manufacture	36·7	38·2	37·4
Hollow-ware	55·7	55·2	58·7
Brass manufacture	40·5	47·8	44·1
Metal industries not elsewhere specified	240·8	219·9	220·8
Precision Instruments, Jewellery, etc.	137·1	128·1	132·9
Scientific, surgical and photographic instruments, etc.	85·0	80·5	82·9
Manufacture and repair of watches and clocks	16·3	14·2	15·7
Jewellery, plate and refining of precious metals	27·6	25·6	25·6
Musical instruments	8·2	7·8	8·7



These diagrams show the distribution of total manpower in the main industry groups in Great Britain for 1952 and 1953.

as evidence, and the unions therefore had to try to base their case upon the increase in productivity which has been achieved in the past five or six years.

They argued that, while productivity had steadily increased, the workpeople had not benefited; real wages had actually fallen, while profits had risen uninterruptedly. There seems to be little truth in the claim that real wages are not higher than in 1947, and the workpeople in engineering have fared no worse than the rest of the community. Average male earnings in engineering have kept in step with the average for all industries. The employers disputed the contention that profits had risen, and, certainly, the distributed profits have not been high. Mr. B. Macarty, Director of the Employers' Federation, pointed out that a representative selection of companies had shown an average return to shareholders of less than 3 per cent., which was less favourable than a number of Government securities. The major proportion of profits have had to be ploughed back into the industry to secure the advances in productivity upon which the men based their claim.

FIXED INVESTMENT LAGS

In the four years up to and including 1951, the total capital outlay by the engineering industry had been £964 millions. Gross fixed capital formation had amounted to £222 millions in engineering, shipbuilding and electrical goods, to £111 millions in vehicles, to £67 millions in metal goods, and to £16 millions in precision instruments and jewellery. This makes a total of £416 millions, the remaining £548 millions being required for financing additional stocks and work in progress. In the four years to 1953, the additional capital employed by engineering and vehicle-manufacturing companies, covered by *The Financial Times* reports, amounted to £416 millions. These figures may seem high as absolute amounts, but, as was argued in the first article in this series, it is fairly clear that fixed investment in engineering has been most inadequate since the war.

This seems to reinforce the employers' case all the more, since it would be a very serious matter if funds urgently required for investment had to be paid out in wages. There is, however, one flaw in the argument. It assumes that, within the limits of the resources available, employers are seizing all opportunities of undertaking investment which will lower costs. Many employers certainly are doing so, but recent trends in bank advances suggest that, despite easier credit facilities, the industry is not making full use of the available investment resources.

Experience in the United States suggests that a most effective way to keep management alive to the necessity of installing the most up-to-date machinery is for the unions to maintain constant pressure for higher wages. In the end, the higher wages can be paid out of the proceeds of the higher efficiency; but the process must, nevertheless, be at least slightly inflationary. It could hardly be recommended for the United Kingdom, at any rate for the present, when inflation might have a disastrous effect on the balance of payments. In pressing their wage claim, the unions have not, in any case, been activated by any such considerations. Aggressive wage policies of the kind pursued in the United States require that less emphasis shall be placed on security of employment than is commonly done by the unions in the United Kingdom, and involve the consequent elimination of many restrictive practices.

The tactics which the engineering unions have adopted to force an acceptance of their claim upon the employers may prove at least partly effective, but they are certainly not in the national interest. The one-day token strike on December 2 affected output so little that it could not have been intended to coerce the employers. It is possible that the union leaders were simply seeking to ascertain the degree of support that they had for the wage claim among the rank and file. They certainly demonstrated that they could rely upon union discipline to produce a fair show of solidarity, though there was by no means 100 per cent. agreement.

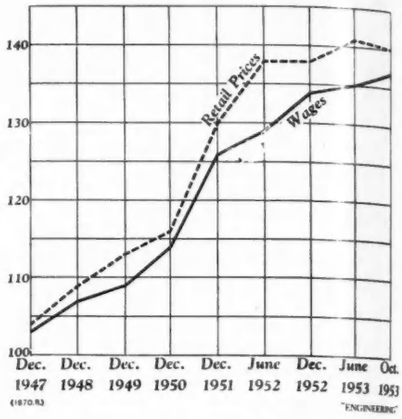
Their success encouraged them to institute a ban on overtime and piecework. From January 18, no more than 44 hours per week were to be worked, and piece-workers were not to put in more work than is necessary to earn their normal equivalent day-work rates. The unions were probably not anxious that they should have to enforce the ban. Their prime object may have been to make a threat serious enough to force the intervention of the Minister of Labour. If so, they were conspicuously successful, for Sir Walter Monckton promptly summoned both sides in the dispute to meet him. It should now be possible to arrange for arbitration, or, at least, for an investigation by a court of inquiry. The unions may thus expect to gain at least something of what they are asking, without compelling their members to submit to the inconvenience of reduced earnings.

Trades unions in general have had good reason to be satisfied with arbitration in the past. There has been no evidence of favouritism to employers in any of the awards, and, a less doubtful blessing, the interests of claimants have not commonly been subordinated to those of the community as a whole. Nevertheless, reasonably rapid reference to arbitration is desirable for the preservation of industrial peace and good will, and it is unfortunate that the negotiating machinery of the engineering industry makes no provision for such a reference in the event of a breakdown. The court of inquiry which investigated the electricians' dispute in October urged the electrical contracting industry to make good this deficiency.

UNPROFITABLE WAGE BARGAINING

The engineering industry is also faced with rising costs as a result of wage increases in other industries. An increase in fuel and power prices is threatened as a result of the miners' claim for increases of 12*s.* 6*d.* to 13*s.* 6*d.* a week, to bring the minimum for surfacemen to £7 and for colliers to £8 a week. In this case, the claim is based not on the relationship of earnings, but of wages to the cost of living. Mr. Arthur Horner, general secretary of the National Union of Mineworkers, has stated that hundreds of thousands of miners had to work overtime to meet the increased cost of living. Although recent average earnings were £10 3*s.* 9*d.* a week including overtime, about 300,000 day-wage men (out of a total labour force of 787,000) were on the minimum wage rate of £6 7*s.* 6*d.* for surface workers and £7 6*s.* 6*d.* for colliers. If wage increases are to be justified on these grounds in the most highly paid industry in the United Kingdom, the consequences may be very serious for the British economy. Building workers (who have already received 1*d.* an hour under a cost-of-living agreement) are claiming an extra 9*d.* per hour. This, according to Mr. W. Horsfall, president of the National Federation of Building Trades Employers, would add £90 millions to the industry's annual wages bill and £90 to the price of an average three-bedroomed house.

The beginning of an inflationary spiral may perhaps already be seen in the decision of the British Transport Commission to seek permission to raise freight and dock charges as well as some passenger fares. Freight charges, which had to be raised by 5 per cent. to yield an extra £12 millions in 1952, may have to be increased by 10 per cent. in early 1954 to meet increases in the price of coal, costing £4 millions, and the recent award of 4*s.* per week for 450,000 workers, costing £5·5 millions per annum. This does not take into account the increase in costs which may result from the recent award obtained by the threat of strike action over the Christmas period. The percentage increase in wages to be conceded has not been finally agreed, but it is thought that the majority of railwaymen will gain an additional 3*s.* per week.



The trend of wage rates and cost of living in the United Kingdom is shown in this graph. The figures are based on an index of 100 in June, 1947.

Railwaymen are not highly paid in relation to other industries, and it is contended that it is unfair to expect them to accept a low standard of living merely because it is apparently impossible to run the railways at a profit. Most Continental railways are subsidised, and it is thought that some Treasury support might reasonably be given to British Railways. A most convenient way of doing this might be to remove responsibility for the interest payable on the take-over stock from the railways and to make it a further charge on the National Debt. Manoeuvres of this sort, however, are not in the interests of the community as a whole, and might obscure the basic need, which is to make the railways run more efficiently. A spokesman of the railwaymen has promised more efficient working in return for the percentage increase in wages. If, in fact, the railwaymen accept all the implications of more efficient working, this will go a long way towards restoring the profitable operation of the railways. Goods and passengers could, no doubt, be conveyed as efficiently as at present with appreciably fewer staff than are now employed. It is not certain, however, that the railway spokesman was thinking in terms of redundancy, and, in any case, the increase in wages was conceded without any actual contractural assurance of more efficient working.

GOVERNMENT INFLUENCE

The concession was made purely and simply because the balance of bargaining strength was in the men's favour. Machinery for negotiation and arbitration has been steadily elaborated in recent years. The Government have more and more taken it upon themselves to offer advice and to exert their influence in wage disputes, but the principle which governs wage advances is still that of bargaining strength. No Government has dared to enunciate a coherent wages policy, and probably no union would agree to be guided by one. Mr. R. A. Butler, the Chancellor of the Exchequer, clearly stated his attitude to the claim of the engineering unions in July, when he said that a rise of 10 per cent. in wages,

other things being equal, would force export prices up by 4·5 per cent., which would "cause a serious fall in the volume of exports."

The Government, however, have little power to ensure that the national interest is the pre-eminent consideration in the negotiation of an agreement. Even when disputes go to arbitration, they can only ensure that the tribunals shall be fully aware of the economic consequences of any awards they are likely to make. The tribunals must, however, concern themselves very largely with trying to reach a solution which will be acceptable by both parties, which means, in effect, judging their relative strength. While the acceptance of their awards is not compulsory, it can hardly be otherwise. Compulsion is not compatible with democracy, which, after all, is founded on the basic assumption that men are reasonable. Men are not always as reasonable as the perfect working of democracy demands, and inopportune and ill-considered wage claims, enforced against the public interest, are but part of the price to be paid for democracy.

PRODUCTIVITY DRIVE

American goodwill in the pursuit of higher British productivity seems boundless. The long series of visits to the United States by productivity teams have been over for some time, although two of the most valuable reports, on "Production Control" and "Design for Production," were published as recently as October. United States assistance is now directed to ensuring that the lessons which have been learned shall be put into practice. Machinery is now well in motion for making use of the £3 millions made available under the Economic Aid scheme; £457,000 has been made available for an advisory service, operated by such bodies as the British Productivity Council and the Department of Scientific and Industrial Research, to give advice, particularly to smaller concerns on production techniques. And £1 million is to be devoted to research and the promotion of studies in all matters relating to industrial efficiency by the universities, professional bodies and such institutions as the British Institute of Management. The publicity campaign in support of the productivity drive is expected to require an expenditure of £178,000 over the next two to three years.

Perhaps the most interesting part of the scheme is the setting up of a so-called "revolving fund" of £1 million, of which £700,000 will be for increasing productivity in industry and the remainder for agriculture. This fund is similar in conception to that, of like amount, given in 1952 to the Industrial and Commercial Finance Corporation to assist industry to purchase fuel-saving equipment Loans under the new fund, which the President of the Board of Trade administers with the help of a special committee, are available at exceptionally low rates of interest – mainly at about 1 per cent. per annum. Preference is given to applications for loans which do not exceed £30,000, and only those which offer quick returns in raising productivity are being entertained. The test of whether the smaller concerns in the United Kingdom are really interested in higher productivity will be the extent to which they make use of these loans.

American assistance in the search for productivity is by no means confined to the United Kingdom. The Mutual Security Agency has also made £9·8 millions available to Western Germany. Credits of £5·8 millions are being extended to small-sized and medium-sized enterprises, and £1·5 millions are being devoted to the creation of an independent Productivity Institute. The corresponding organisation in the United Kingdom, the British Productivity Council, has been criticised for slow progress since it was founded in March. This, however, is unjustified. Local committees had been established in about 100 towns and districts by the end of 1953. It is the function of the council to foster, but not to control, the local committees. A local committee is started by the chairman of the district advisory committee (attached to the Regional Board for Industry) calling a conference to discuss its formation. The local committee, when formed, is immediately independent, and the first task is to assess the local problems which will require their main attention. Surveys are made by postal questionnaires and personal visits to local manufacturers. Inter-factory team visits are arranged, and the pattern of local problems and needs quickly emerges. This system should produce more rapid and satisfactory results than over-much centralised activity. The problems of London are, after all, not those of Inverness.

The two most recent productivity-team reports repeat many of the findings of other teams. Both reports stress the sense of urgency and purpose behind the pursuit of productivity by both managements and workpeople in the United States. That on "Production Control" points to the comparative youthfulness of the American executives, and the high calibre of the men engaged in production planning and control is significant. This report is of particular interest in the importance it attaches to an adequate assessment of markets as the basis for all successful planning. In the United States, extensive use is made of past history and countrywide statistics. Forecasts are then made of the portion of the market to be "earmarked" by any company as its share. Some large concerns find it practical to operate on forecasts of five years ahead.

DESIGN, SALES AND PRODUCTION

The production control team also draws attention to the close co-operation that exists in the United States between design, sales and production staffs, a subject which is treated very fully in the report on "Design for Production." In this it is stated that the struggle for higher productivity has reached a pitch that demands specialists to study and modify designs for the sole purpose of cheapening production. The average designer cannot be expected to be a specialist in both the functional requirements of the product and adapting it for production. Individuals, and even departments, are therefore employed in the United States to form a link between the design and production departments, whose responsibility it is to see that designs are easy to manufacture at the least cost. Methods engineering, in this sense, is not of course unknown in the United Kingdom; but the number of staff engaged on it is small in relation to the United States, where 3 per cent. of a company's labour force may be engaged in applying it continuously and intensively to current products as well as to new.

The proportion of staff engaged in implementing standardisation policies is also high. In one large concern, employing 15,000 workpeople, it was 7 per cent. of the total drawing-office staff; in smaller concerns, it was sometimes even higher. The authority given to standards engineers is considerable. They are generally responsible to the higher technical management, and carry out their functions in collaboration with both the chief designer and the chief engineer. One of the companies visited used a designer of considerable experience, one of the very few indispensible persons in the organisation, merely to examine all designs for any lapse in the use of standard parts. This may be carrying things too far, but it would be an excellent thing if such a sense of vital importance of standardisation were more general in the United Kingdom.

Standardisation, together with simplification and specialisation, according to Mr. Graham Hutton, are "the three charmed 'Ss' of high productivity," which are applied to all aspects of production in the United States – to management as well as to materials and machines. Mr. Hutton was called on by the British Productivity Council to do a final analysis of the reports submitted by the 66 teams which visited the United States, and to bring out all the general lessons contained in them. The result was the book *We Too Can Prosper*, in the preparation of which the author had the assistance of Mr. Geoffrey Crowther, the British Employers' Confederation, the Federation of British Industries, and the Trades Union Congress.

Mr. Hutton finds that British productivity must be raised, and can be raised comparatively quickly. The alternative is "an accelerating, and ultimately catastrophic, fall in our standards of living." The productivity of labour in the United States, where private capital investment has been running at "the astounding rate" of 50,000 million dols. per annum – nearly double the total national output of the United Kingdom – has been rising by about one half every ten to 15 years. It has been argued that the United Kingdom could compensate for losing ground in productivity by maintaining technical pre-eminence. This seems, however, rather an illusory hope, for, as Mr. Hutton points out, much more is spent on research in the United States than in any other country; the number of professional workers employed in research laboratories in the United States is now five times greater than 20 years ago. There is no escape from the necessity of increasing British productivity as the prime means of selling British goods in world markets. Mr. Hutton is optimistic about the prospects and thinks that an overall increase of 10 to 15 per cent. in productivity, achieved in two to three years, is more feasible in the United Kingdom to-day than in the United States. The foundations for achieving such an increase have certainly been well laid. Everything now depends upon the will and determination of managements and workpeople.

* * *

CITY AND GUILDS COLLEGE

Over a Thousand Engineering Students

The forty-sixth annual report of the Imperial College of Science and Technology, which comprises the City and Guilds Engineering College, the Royal School of Mines, and the Royal College of Science, has recently been issued for the year ended July 31, 1953, and shows there was a total of 1,653 full-time students as against 1,643 for the previous year. Of the 1,653 students, it is stated that 198 came from Commonwealth countries and 114 from foreign countries, which gives one overseas student in almost every five.

In spite of the high standard demanded to pass from year to year in the constituent colleges there was a negligible percentage of failure among the senior students to attain academic distinction, and the total number of successes was no less than 1,040 in 1952-53 as compared with 887 in 1951-52.

More than half of the total number of full-time students during the year under review took courses in engineering at the City and Guilds College, there being 1,095 engineering students, as against 927 in the preceding year, which underlines the ever-increasing demand on the educational facilities afforded by this College.

THE CONTINUITY OF ELECTRICITY SUPPLY*

CAUSES AND CLEARANCE OF FAULTS ON POWER SYSTEMS

By H. Leyburn, B.SC.(ENG.), A.C.G.I., M.I.E.E.

The late Sir Charles Parsons' main interest in life – namely, his work on the steam turbine – contributed in no small measure to the fulfilment of the supply authorities task of providing a cheap and abundant supply of electricity. Implied in this task is the necessity for the supply to be continuous, an aspect of the subject which falls naturally into three main sections : the design and operation of power systems under normal conditions of service; the causes and effects of disturbances on these systems and the measures taken to avoid them; and the means of avoiding interruptions of supply, if faults occur.

It soon became apparent that the increasing demand for electricity could only be satisfied economically by some form of interconnection of power stations, thus reducing the amount of generating plant and improving the reliability of the supply. To achieve this aim, however, it is essential to have means available for disconnecting faulty equipment without at the same time disconnecting healthy apparatus. In fact, without such means an interconnected network would be less reliable than an isolated system.

METHODS OF INTERCONNECTION

Various types of interconnection are available, including the radial feeder, different variants of the ring main and an extension of the latter in which some of the stations connected to the mains are also interconnected by additional feeders. This arrangement can be still further extended by interconnecting power stations and groups of power stations as on the British grid. The choice of any particular system depends largely upon the degree of continuity required and this, in turn, depends upon the economic importance of the load. Broadly, in a highly-industrialised country like Great Britain, radial feeders are restricted to voltages up to 11 kV, ring mains and interconnected systems from one power station are used up to 66 kV, and power-station inter-connectors are operated at 132 kV and 275 kV and occasionally at 66 kV.

One of the basic features necessary to keep the system running moothly is that each individual component should be utilisable to the fullest extent. A second feature is that the components must be of sound design and manufacture, fully proved and properly co-ordinated with each other. Thirdly, there must be efficient load dispatching, so that the system can be controlled, the fluctuations in load followed, and action taken in advance on previously obtained data, such as load charts and meteorological reports.

CAUSES AND EFFECTS OF FAULTS

In many countries lightning is the biggest single cause of faults and even in Great Britain about 40 per cent. of the faults on overhead lines and about 20 per cent. of all faults on power systems are due to this cause. Accordingly, much effort is being devoted to the photographic and electrical recording of lightning strokes and the compilation of lightning fault statistics on transmission lines.

* The Parsons Memorial Lecture delivered before the Institution of Electrical Engineers on Thursday, January 7. Abridged. Mr. Leyburn is with A. Reyrolle and Company, Limited.

The most important factors in lightning protection work are the current magnitude and the wave shape of the discharge. Currents up to 100,000 amperes have been recorded, the average being about 20,000 amperes. The wave shape varies widely, but for the purposes of simulating lightning surges when testing, a unidirectional impulse voltage having a shape of 0·02 microsecond has been standardised in this country. That is to say, the impulse voltage reaches its maximum amplitude in one microsecond and then decreases to one half the maximum in 50 microseconds. Among the many devices intended to provide protection against lightning are the earth wire, the surge diverter, co-ordinating arc gaps, arc-suppression coils and the automatic re-closing of circuit-breakers.

Another cause of breakdown is insulation failure due to adverse weather conditions. An example is the flash-over of overhead line insulators due to atmospheric pollution, although this has been greatly reduced by the use of anti-fog insulators. Failure due to the long-term effects of the normal service voltage may occur with solid insulation, owing to bad design or to some extraneous factor, such as the ingress of moisture. The percentage of failures due to this cause has, however, been decreasing as design, manufacture and testing have improved. Faults in power systems are also caused by errors of the personnel and for such miscellaneous reasons as broken overhead conductors, aeroplanes and branches of trees striking the line or workmen driving pickaxes into a cable.

INSULATION LEVEL

Closely linked with the protection of a power system against lightning are the questions of its insulation level and insulation co-ordination. By this is meant the assignment of insulation levels to different apparatus and to different portions of the same apparatus, in such a way that the incidence of flashovers is reduced while, if they occur, they will cause as little damage as possible. The general level of insulation must be such that there will be no flashover or breakdown when the highest possible " internally generated " voltage is impressed upon it. This voltage is that produced by the system itself and reaches a maximum when a highly inductive or capacitative circuit is switched off. Its magnitude depends both on the design of the circuit-breaker and the circuit constants, but does not exceed 3 to 4 times the working voltage in a well-designed system.

Having decided on the general level of insulation which will withstand this voltage, the difference between the levels of various portions of the apparatus can be established, so that flashovers will occur where they are least harmful. While, in the past, insulation levels were based on power-frequency voltages, the tendency now is to base them on unidirectional impulse voltages approximating to lightning surges.

METHODS OF FAULT CLEARANCE

Whatever efforts are made to avoid faults, it is, however, impossible to eliminate them. Protective systems and circuit-breakers are therefore necessary, the former discovering and locating the fault and the latter removing or isolating it. Without either of them, continuity of supply cannot be ensured under fault conditions. Their joint duties are to minimise the damage done by the fault at its location ; to ensure that healthy pieces of equipment are not damaged; and to avoid dislocation of the system through instability.

The times taken by the protective system and the circuit-breaker to isolate a faulty piece of equipment have become progressively shorter and on most modern transmission systems total clearance times of about 0·2 second or less are usual. This time must be further reduced on systems in which stability might be endangered if a fault were allowed to persist too long. Instability depends on many factors, but is more likely to occur the greater the dissimilarity between machines running in parallel, the higher the reactance of the lines connecting them and the greater the load transmitted. If a fault occurs on such a system, particularly between all three phases, the current flowing between the machines and keeping them in step will cease to flow. They will then run at different speeds, while the fault lasts. By the time it is removed they may be out of step so that heavy currents of variable magnitude will flow between and system instability will occur. On the Swedish transmission system, where such conditions are likely to arise, special efforts have been made to make the total time of fault clearance as short as possible and it is claimed that 0·08 second or even less has been reached.

PROTECTIVE SYSTEMS

Much thought and ingenuity have been devoted to the development of discriminating protective systems, the characteristic of which is that they operate when a fault occurs on the equipment they protect, but otherwise remain stable. Most of them depend for their functioning on intelligence conveyed from one end of the protected apparatus to the other and this to a great extent determines the degree of difficulty in their design.

To illustrate the general principles upon which such systems are based, mention may be made of three used for protecting feeders. In the first of these the current entering the feeder is balanced, both in phase and magnitude against the current leaving it. If, however, any unbalance between the outputs occurs due to a fault, relays operate and cause the circuit-breaker to isolate the feeders. Various difficulties were experienced with this system in the past, but these have been overcome, and one or other variety of balanced protection is now used as a matter of course in most important cable networks and often for the protection of short overhead lines in Great Britain.

PHASE-COMPARISON SYSTEM

The second system depends for its operation upon a comparison of the phase relationship between the currents at the two ends of the protected feeder. Under fault conditions signals are transmitted from end to end on every alternate half cycle of the fault current. When a fault current flows through a healthy feeder the signalling is continuous and the relays do not operate. Under internal fault conditions, however, the signalling becomes discontinuous and the relay operates the associated circuit-breaker. The system is particularly suitable for the protection of overhead lines where pilot wires cannot be made available, carrier currents at frequencies from 80 to 500 kilocycles being used as the channel of communication.

In the third, or time-distance, system the stability is not entirely independent of what happens in adjacent feeders. Under fault

conditions the voltage and current at a feeder end are compared and the impedance of the fault loop is measured. This gives the distance of the fault from the relay and the time of operation of the latter is dependent upon it. If the fault is farther away than about 80 per cent. of the length of the protected feeder, the relay operates with a time lag which is just sufficient for a fault in an adjacent feeder to be cleared. In that case the relay does not complete its operation and re-sets itself. Designs are available which give satisfactory protection to overhead lines without the use of pilot wires. An inherent disadvantage of the time-distance system is that it has a time lag when a fault occurs at the far end of the protected feeder. It cannot therefore be used by itself on systems which are prone to instability.

CIRCUIT-BREAKING METHODS

After the protective system has located the fault, it initiates the operation of a circuit-breaker which disconnects the faulty unit. In actual practice this is done by removing a short length of conductor. This removal presents many difficulties, which have been accentuated by the increase in transmission voltages, by the concentrations of fault power that have to be controlled and by the high speeds of operation required to avoid instability. Basically there are only three types of circuit-breaker: the oil, the air-blast and the air-break.

An oil circuit-breaker consists essentially of one or more pairs of contacts in an oil-filled enclosure between which an arc is drawn when the circuit is opened. This arc vaporises part of the oil and is extinguished at a current-zero when the dielectric strength of the space between the contacts exceeds the re-striking voltage tending to re-establish the arc. The time taken for sufficient pressure to be built up to extinguish the arc has been reduced by arc-control devices. In the air-blast circuit-breaker the arc is also extinguished at a current zero by a blast of air from an external source. In the air-break circuit-breaker, on the other hand, the contacts are in air and when they part the arc is forced by magnetic and thermal means into a chute. There it is elongated and cooled until it is extinguished at a current zero not by pressure or by a blast of oil or air, but by gradually lengthening it.

TESTING AND PROVING

Testing and proving circuit-breakers, particularly those with high short-circuit ratings, necessitates the building of large and costly short-circuit stations with outputs at least a substantial percentage of the full short-circuit rating of the largest high-voltage apparatus. To overcome this difficulty the full short-circuit current is applied at the highest voltage the testing station can deliver and this is followed by a test at the rated voltage with the highest current available. Provided the testing station output is not too small, this method is reasonably successful for proving oil circuit-breakers. In a second method, the full short-circuit current is obtained from the testing generators and the rated voltage from an independent source. Whatever its advantages for research, this method is hardly sufficiently developed for proving purposes. The third method is applicable to circuit-breakers which are built up of a number of similar units in series and consists in subjecting each of them to a test at a short-circuit power corresponding to its share of the duty. This method is useful and is being improved. The duty imposed when interrupting small reactive or capacitative currents may in some respects be even more severe than that caused by large short-circuiting currents. The ability of a circuit-breaker to deal with these conditions must therefore also be proved and much development work is being done in this direction.

SELECTION OF EARTHING METHODS

There are a large number of other items which are important from the point of view of continuity of supply. One of these is the selection of the most appropriate method of earthing, as this may have a great effect on the insulation level of the system, on the protective equipment and on circuit-breaking. Transient faults which allow the system to carry on after they have been cleared can be dealt with by earthing the neutral point of the system through an arc-suppression coil or by installing automatically reclosing circuit-breakers.

Finally, there are a number of problems which require better solutions than those at present available. These lie mainly in the direction of simplifying and cheapening the equipment and in shortening the clearance times of faults. The natural increase in demand is likely to necessitate the transmission of still larger blocks of power over longer distances at higher voltages or by direct-current. Long-term developments depend, for example, on the employment of atomic power stations and on the sites likely to be chosen for them.

PLASTIC THEORY FOR A TRUSSED STEEL BEAM WITH A CENTRAL LOAD

By R. W. Steed, B.SC.(ENG.), PH.D., A.M.I.C.E., A.M.I.MECH.E.

The basic principles of the plastic theory, as applied to mild-steel structures, have been stated in many papers.[1] The term "collapse load," as it is used in this article, is defined as that load which, if applied to a structure, will cause large deformations to develop without application of further load. The "load factor" for any structure is then defined as the ratio between the collapse load and the working load to be applied to the structure; the load factor is necessarily, therefore, greater than unity.

Suppose it is required to design the trussed beam shown in Fig. 1, herewith, all members being of mild steel, to support a working load F. With a load factor of L_1 the design load is $L_1 \times F = W_1$. For design purposes let an arbitrary proportion, $K_1 < 1$, of this design load be allocated to the strut D E; this will determine the design load in the tie members A E and B E. The cross-sectional areas of the ties and strut can then be theoretically proportioned so that the design loads in these members are the capacity loads in each case, that is, if f is the yield stress for the ties,

$$A_1 = \frac{K_1 W_1 \operatorname{cosec} \theta}{2f}, \quad . \quad . \quad (1)$$

where A_1 is the theoretical cross-sectional area required for the ties. If $\frac{f}{R_1}$ is the design stress for the strut, where R_1 is a numerical value > 1 (since the maximum stress attained in the strut is to be $< f$) then

$$a_1 = \frac{K_1 W_1 R_1}{f}, \quad . \quad . \quad (2)$$

where a_1 is the theoretical cross-sectional area required for the strut.

The ultimate bending moment M_U, on the beam at D is

$$M_U = \frac{W_1 (1 - K_1) l}{4}, \quad . \quad . \quad (3)$$

and the beam must be so proportioned that its moment of resistance is equal to this bending moment. The plastic moment of resistance of the beam is $e_1 \times S \times M_E$ where, M_E is the elastic moment of resistance of the beam; S, a shape factor for the beam; and e_1, a numerical value, < 1, to allow for the reduction of the full plastic moment, $S \times M_E$, because of the axial force, $\frac{1}{2} K_1 W_1 \cot \theta$, in the beam. For standard I-sections, bent about the major axis, it has been found that the shape factor, S, varies very little from 1·15, and this figure can be used for the design of such sections.[2] For the same sections, suitable design values for e_1, based on previous work[1,2], are given in Table I, where f_a is the axial stress and f_b the yield stress in bending.

TABLE I.—*Reduction Factors*

$\frac{f_a}{f_b}$	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
Reduction factor	0·97	0·92	0·83	0·73	0·63	0·51	0·39	0·26	0·13	0

Then $M_E = f_b \times Z_1$ where Z_1 = elastic section modulus required for the beam. Now, if $f_b = nf$, where n is some numerical factor,

$$e_1 S n f Z_1 = \frac{W_1 (1 - K_1) l}{4}.$$

Therefore the required section modulus is given by

$$Z_1 = \frac{W_1 (1 - K_1) l}{4 e_1 S n f}. \quad . \quad . \quad (4)$$

For any arbitrary value of K_1 and a suitable choice of load factor L_1, the structure can thus be theoretically proportioned, although the values of A_1, a_1 and Z_1 would have to be adjusted later to the nearest higher practical values above those given by equations (1), (2) and (4) to give A and a as convenient cross-sectional areas of the ties and strut respectively and Z as a convenient elastic section modulus of the beam. The use of practical sizes, however, tends to increase the value of the collapse load for the structure to a value W and hence the true load factor above L_1.

The collapse load, W, for the designed structure, having practical sizes for its members, can now be quickly calculated and the correct load factor, L, evaluated. The proportion of the collapse load taken by the strut, K W, and the axial force in the beam can then be calculated and the values of R and e determined.

Hereafter, the article is concerned only with the designed structure having practical, as opposed to theoretical, sizes for its members.

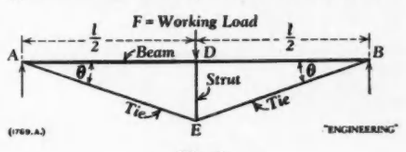


Fig. 1

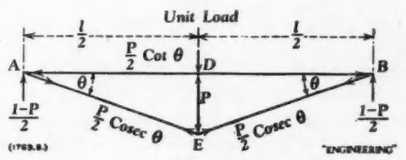


Fig. 2

Fig. 2 shows the elastic load distribution for a unit load applied to the beam while all parts of the structure are still in an elastic condition. It can be shown[2] that, if the structure is assumed to be pin-jointed at A, B, D (the beam is continuous, but the strut is pinned to the beam) and E, then,

$$P = \frac{\frac{l^3}{48\,I}}{\frac{\mathrm{cosec}^3\theta\sec\theta}{4A} + \frac{\tan\theta}{2a} + \frac{l^2}{48\,I}}, \quad (5)$$

where I = second moment of area of the beam. The value of Young's Modulus is constant throughout the structure and the effect of the thrust in the beam is neglected as having little influence on the value of P. Furthermore, it is thought permissible to assume that the above expression will obtain for a practical structure. On substitution of $A = \frac{K\,W\,\mathrm{cosec}\,\theta}{2f}$, $a = \frac{K\,W\,R}{f}$ and $Z = \frac{I}{y} = \frac{W(1-K)\,l}{4\,e\,S\,n\,f}$, where y is the distance from the neutral axis of the beam to its extreme fibre, it is found that

$$P = \frac{\frac{l_2\,e\,S\,n\,f}{12\,W(1-K)\,l\,y}}{\frac{f\,\mathrm{cosec}^3\theta\sec\theta}{2K\,W\,\mathrm{cosec}\,\theta} + \frac{f\tan\theta}{2K\,W\,R} + \frac{l^2\,e\,S\,n\,f}{12\,W(1-K)\,l\,y}}.$$

Dividing throughout by $\frac{l\,e\,S\,n\,f}{12\,W(1-K)\,y}$ and re-arranging.

$$P = \frac{1}{1 + \frac{(1-K)\,C}{K}}, \quad . \quad . \quad . \quad (6)$$

where $C = \frac{6\,y}{l\,e\,S\,n}\left(\mathrm{cosec}\,\theta\sec\theta + \frac{\tan\theta}{R}\right)$. (7)

It is extremely unlikely that capacity loads in the ties and capacity moment at D will be attained at the same instant under the ultimate load W; either the capacity load will be reached first in the ties, at some intermediate value of load, and then the capacity moment attained at D, or vice-versa. Assume the first of these alternatives to occur under an applied load W_y ($W_y < W$). Then

$$\frac{P\,W_y\,\mathrm{cosec}\,\theta}{2} = \frac{K\,W\,\mathrm{cosec}\,\theta}{2},$$

therefore

$$\frac{W_y}{W} = \frac{K}{P}. \quad . \quad . \quad (8)$$

Considering the second alternative, since $W_y < W$, the axial force in the beam ($\frac{1}{2}\,P\,W_y \cot\theta$) will be less than the design force of $\frac{1}{2}\,K\,W\cot\theta$. Therefore the reduction factor, e', for the full plastic moment will be less than the design reduction factor, e. The bending moment at D will be $\frac{1}{2}\,W_y(1-P)\,l$ and, for this alternative, the bending moment will also be equal to $e' \times S \times M_E$. But

$$\frac{W(1-K)\,l}{4} = e\,S\,M_E,$$

therefore

$$\frac{W_y}{W} = \frac{(1-K)\,e'}{(1-P)\,e}. \quad . \quad . \quad (9)$$

It is obvious from equations (8) and (9) that if $P > K$ then the ties will yield before the capacity moment is reached at D (as $\frac{W_y}{W}$ must be less than unity) and vice-versa if $P < K$.

It is required to know therefore, whether P is greater than or less than K; that is, from equation (6), it is required to know whether $\frac{K}{K+(1-K)C}$ is greater than or less than K. This leads to the following: if $C < 1$, $P > K$, that is, if

$$\frac{6\,y}{l\,e\,S\,n}\left(\mathrm{cosec}\,\theta\sec\theta + \frac{\tan\theta}{R}\right) < 1, \; P > K.$$

Taking the minimum possible values of S, n and R as 1·15, 1·0 and 1·0 respectively, then for $C > 1$, when

$$\theta = 15\text{ deg.}, \frac{l}{y}\text{ must be} < \frac{22{\cdot}3}{e},$$

$$20\text{ deg.}, \frac{l}{y}\text{ must be} < \frac{18{\cdot}2}{e},$$

$$25\text{ deg.}, \frac{l}{y}\text{ must be} < \frac{16{\cdot}1}{e}.$$

Since 15 deg. can be taken to be the minimum practicable value of θ, it is thought unlikely even under the worse conditions chosen, that $\frac{l}{y}$ will be $< \frac{22{\cdot}3}{e}$. Hence, in any practical design, the capacity load will be reached in the ties before the capacity moment at D is attained.

The condition under the working load, for the case where the capacity load is first reached in the ties, is obtained from equations (6) and (8), giving

$$\frac{K}{P} = K + (1-K)\,C; \text{ whence } C = \frac{\frac{K}{P} - K}{1-K};$$

It follows that if

$$C > \frac{\frac{1}{L} - K}{1-K}, \quad . \quad . \quad (10)$$

then

$$\frac{K}{P} > \frac{1}{L}.$$

It follows then that if equation (10) is true for any particular design, then all parts of the structure will be in an elastic state under working conditions. The central deflection under the working load F, will be given by

$$\frac{F(1-P)\,l^3}{48\,E\,I}. \quad . \quad . \quad (11)$$

DESIGN STEPS

The design steps for the type of trussed beam shown in Fig. 1 are therefore as follow:—

1. Knowing the working load and the configuration of the structure, select a suitable load factor and calculate the design load.
2. Allot an arbitrary proportion of the design load to the strut.
3. Determine the theoretical proportions of the structure from equations (1), (2) and (4) (assuming a value for e_1 and subsequently checking).
4. Select suitable practical sizes for the members.
5. Calculate the collapse load for the designed structure (using the value of e already determined and again subsequently checking) and hence evaluate the proportion of this load taken by the strut.
6. Determine the true load factor for the structure and the values of e and R.
7. Calculate C from equation (7).
8. If elastic conditions are required for all members under the working load, then ensure that

$$C > \frac{\frac{1}{L} - K}{1-K}, \text{ equation (10).}$$

9. Calculate P from equation (6) and hence obtain the central deflection under working load from equation (11).

Many papers have been published considering the analysis of structures using the plastic theory; few, however, have considered the design of particular structures. The structure considered in this article is rather specialised, but it will be appreciated that the approach indicated can be applied to other types of trussed beam under various load conditions.

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CONVEYING PETROLEUM PRODUCTS

PIPE-LINE IN EASTERN CANADA

The entire 442-mile Trans-Northern petroleum-products pipe-line from Montreal, Quebec, to Toronto, Ontario, is now operating smoothly. Constructed at a cost of 19 million, dols. it was completed late in 1952 within five months of welding the first pipe. It is capable of handling 19 different refined products, including motor spirit, Diesel fuel, stove and furnace oils and it can also be used for the transport of liquefied petroleum gases. The products are pumped through the line at approximately four miles per hour by eight electrical centrifugal pumps of 600 h.p. each, and about four days are required for them to travel from Montreal to Toronto. The engineering features of the line include: three types of control for throttling, regulation of pumping power and safeguarding of pumping units; the separation of the control building from the pump building for safety reasons; and facilities for reversed-flow operation in the Clarkson-Toronto section.

Ownership of the Trans-Northern Line is shared equally by British American Oil Company, Limited, the McColl-Frontenac Company, Limited, and the Shell Oil Company of Canada, Limited. The route taken by the pipe-line, and the location of the pumping stations, is shown in the accompanying map, Fig. 1. The capacities of the Montreal refineries of these companies are: 40,000 barrels per day (b/d), 19,100 b/d and 33,000 b/d, respectively. The three companies united in promoting this project in order to achieve the economic advantages of flexibility and continuity of pipe-line transport in a region where tanker movements are stopped by ice for five months each year. Faced with the prospect of meeting the 10 per cent. annual increase in demand for oil products between Montreal and the Hamilton-Toronto area, the companies preferred to build the Trans-Northern system rather than provide additional tankers and the necessary storage for carrying supplies through the winter months.

The pipe-line has no tanks since all movements are to and from the companies' storage at refineries and the ten terminals. In short, dependable delivery and operational flexibility will give these companies important advantages

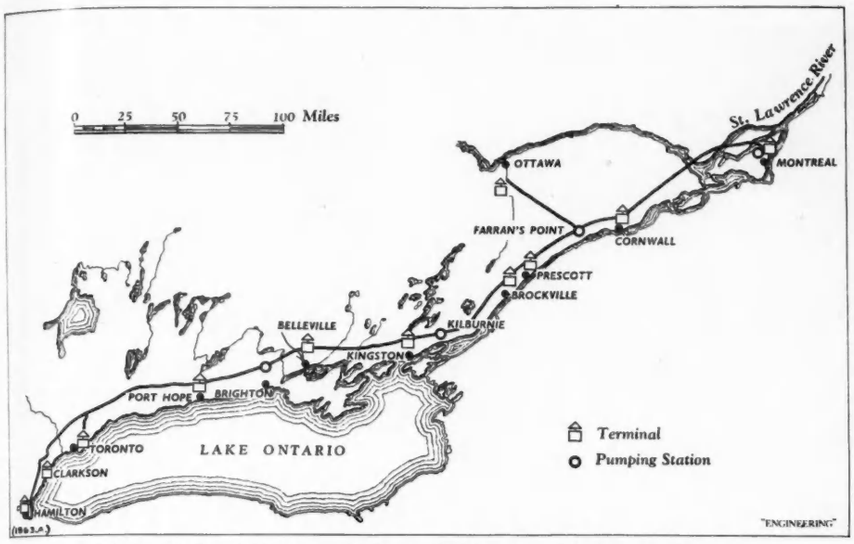

Fig. 1 Route of the Trans-Northern Pipe-line from Montreal to Toronto.

in the Toronto area which has now become the focal point where products refined from foreign crude oil meet those obtained from Western Canadian petroleum. For this reason the pipe-line is not operated for profit. The pipe-line also provides strategic advantages to Eastern Canada in an emergency. Being less vulnerable to major sabotage than the canal system, there is a greater assurance of uninterrupted transportation. Furnishing another alternative route, it is expected to ease the strain on Canada's railway and marine systems. Furthermore, the line could be reversed, if necessary, to carry crude oil from Western Canada or mid-continent oilfields to refineries in Montreal if ocean shipping were cut off.

Important features of the pipe-line are precision pumping and continuous control that are maintained at the dispatching office. All the products are metered into the system at Montreal East and are again metered out at the various delivery terminals. This enables each owner company to receive at its terminal exactly the same barrel of product that its refinery delivered into the line. Tank storage terminals, individually owned and operated by the three companies, and varying in storage capacity according to the requirements of local markets, have been erected along the pipe-line route. From these terminals each company's own road tankers distribute the products to homes, industries and service stations in the area.

The various fuels are pumped through the line in sequence according to their specific gravity. Grade I petrol would, for example, be followed by grade II petrol, and the latter by kerosene. Mixing of the products where they meet is negligible since any tendency for the products to commingle is minimised by modern techniques of controlling pressure and turbulence. Positive displacement meters measure the amount of products into, and out of, the pipe-line. Motor-operated valves on the pumps and automatic throttling valves maintain the prescribed rate of flow of products.

Montreal is the key station, and all others relate their working pressure and rate of flow with those established there; the meter station at Montreal is shown in the accompanying illustration, Fig. 2. Controls keep the line pressure within certain limits, approximately 1,000 lb. per square inch. A teletype system links the four pumping and ten meter stations. Resident operators man the pumping stations and specially trained operators control deliveries at terminals. Trans-Northern's own dispatching office handles the consignments tendered by the refineries of the three owner companies and each consignment is conveyed through the line, the quantities being metered and drawn off at the companies' terminals en route.

CONSTRUCTION WORK

The Trans-Northern system comprises a 10-in. diameter pipe-line, 400 miles long, with an 8-in. diameter spur, 42 miles long, from Farran's Point, near Cornwall, Ontario, to Ottawa. The four pumping stations have been equipped initially for a daily load of 40,000 barrels. The pipe was coated and wrapped for 45 per cent. of the length of the line, being covered with coal-tar enamel, glass mat and asbestos felt. At river and stream crossings this protective material was shielded by wooden slats, as shown in Fig. 3, herewith. During pipe laying, the contractors laid 17-lb. double-packed magnesium anodes to provide cathodic protection of certain bare sections of the pipe and additional anodes will be installed for this purpose in the future as required. The terrain of the pipe-line route is generally rolling, with only a thin covering of glacial soil in most areas. The longest water

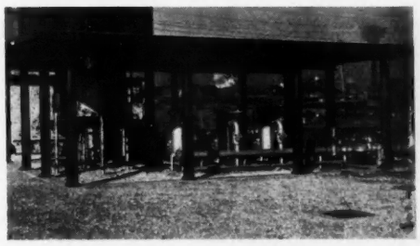

Fig. 2 Meter station at Montreal, where the petroleum products begin their journey through the 442-mile line.

crossing extended 7,700 ft. at the Lake of Two Mountains. Around Hamilton Harbour the line runs 31 miles along the causeway and under the ship channel at a depth of 40 ft. All the water crossings were inspected by divers. Some of the equipment used during the constructional work is shown in Figs. 4 and 5, on page 80. Fig. 4 shows a side-boom tractor being used to support the pipe line while a team of welders complete a weld on the 10-in. line. Rust and scale were removed by mobile cleaning machines of the type shown in the second of these two illustrations. The welds were inspected by gamma-ray and X-ray photography. After completion, the line was tested by water pressure at 1,350 lb. per square inch. One novel feature of construction was the laying of the 10-in. line of Trans-Northern Group and the 10-in. line of the Sarnia-Toronto system of Imperial Oil, Limited, in a single 42-in. wide ditch concurrently for a distance of 30 miles in an area near Toronto where only a narrow lane was available; this collaboration resulted in substantial savings to both companies. The acquisition of rights of way for the 440 miles of Trans-Northern involved procuring no less than 2,900 easements because of the narrow strip land division characteristic of the stretch along the St. Lawrence River.

The expansion of capacity of the system is planned in four stages. The initial installation comprises two 600-h.p. units at each of four stations at Montreal, Farran's Point, Kilbarnie and Brighton, with a capacity of 40,000 b/d. The first of the four stages involves the addition of a unit to give three 600-h.p. units at each station, bringing the total capacity to 50,000 b/d.; secondly, the building of inter-booster stations half-way between existing stations, each to have

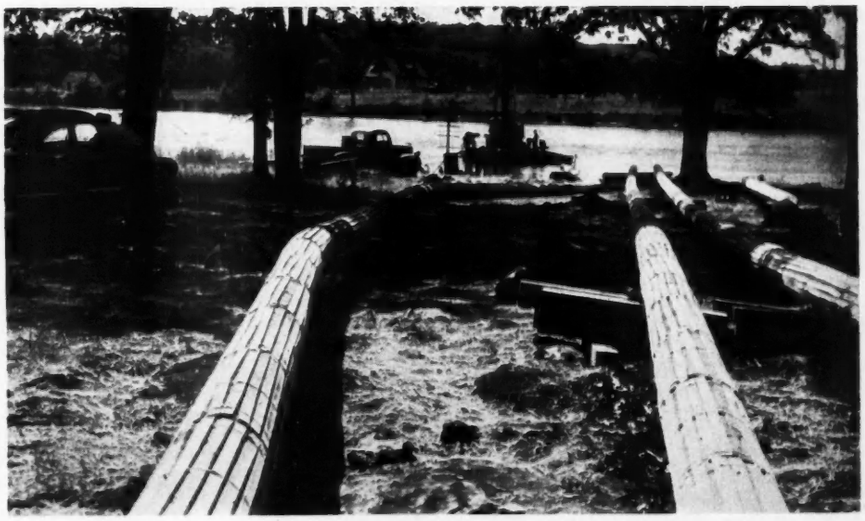

Fig. 3 Sections of pipe, covered with wooden slats in addition to other wrappings, lined up at the Trent River crossing.

Fig. 4 While a side-boom tractor holds the pipe, welders complete a weld on a 10-in. line.

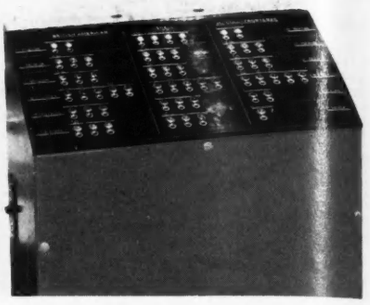

Fig. 6 Push-button switchboard controlling the sequence of closing and opening valves. By inserting one plug into the appropriate socket, the operator determines the product being put into the pipe-line.

two 600-h.p. units, probably remotely controlled, to achieve an aggregate capacity of 60,000 b/d.; thirdly, the addition of a half unit of 300-h.p. at all stations, including booster stations, to bring the total capacity up to 75,000 b/d.; and fourthly, a further expansion of capacity to be provided by looping.

PUMPING CONTROLS

At the pumping station, the control system is characterised by three main features. Firstly, throttling at the discharge side of the station is accomplished by a Hydron valve; these valves were developed by the Shell Oil Company. Being totally hydraulic in operation, they avoid the disadvantages of pneumatic throttling equipment which would call for dehydrators in a cold climate. Moreover, the valve functions independently of other controls. Discharge pressures are between 850 and 1,000 lb. per square inch, and the minimum suction pressure, 50 lb. per square inch. Secondly, the pumping units are regulated by a Teldyne electronic integrator and differentiator of the remote pressure-transmitter type. This is actuated by the difference in pressure between suction and discharge at the station, thereby automatically starting or stopping pump units so as to meet the hydraulic requirements of the pumping schedule of the pipe line. This equipment and the Mercoid controls are connected to the same electric control system of the station, though the Teldyne and Mercoid controls function independently. While the Mercoid switches function according to conditions at individual pumping units, the Teldyne control system is actuated by the differential range or throttling loss across the Hydron valve; the Teldyne " floats " with line load and operates electrically to start or shut down a unit. Lastly, safeguarding the pumping units is achieved by Mercoid switches which shut down individual units when pressure or mechanical conditions exceed those for safe operation. The pumping units are started and stopped by push buttons initiating a series of operations familiar in modern pipe-line practice. The leucite sheet on the control desk carries a diagram representing all units, piping and valves and lights to indicate which units are in operation as well as the " open-and-closed " condition of the valves. Lighted arrows show the direction of flow. The valves at the scraper traps are operated and controlled by push buttons from the control desk.

SAFETY PRECAUTIONS

All the indicator and recording instruments are of the strain-gauge type, giving the Trans-Northern Pipe-Line Company an electric system which has the advantage of eliminating the hazards involved in running liquid-carrying control lines to the control room. Instruments on the control board continuously indicate and record suction and discharge pressures of units, pressures along the line and also differential pressures across the Hydron valves. Lights on the control desk and an audible siren indicate dangerous conditions. In addition to signals for low suction and high discharge pressures, there are also signals for indicating the location of troubles which cause shut-down due to overheating of motor windings, excessive case pressures, insufficient seal-oil pressure, excessive seal-oil temperature, insufficient seal-oil liquid level, stoppage of the sump-pump, and occurrence of leaks which also cause station shut-down.

A pressurised seal-oil system in connection with double mechanical seals for the pumps maintains a differential of 25 to 50 lb. per square inch pressure above the first-stage pump pressure. It has a small rotary pump for maintaining continuous seal-oil flow and pressure. Any leakage of seal-oil causes the isolating fluid to move forward to a point where an electric contact gives a signal at the control board. The safety provisions of this pressurised seal-oil system should be particularly valuable when liquefied petroleum gas is being transported. Sump pumps are operated by float-actuated automatic controls which provide constant drainage of sumps. Stoppage of the pump is signalled to the control board. The comprehensive provisions for station-control and safe operation would facilitate the installation of a remote-control system should it be deemed desirable in the future. The arrival of " tender heads," or change points in the products flowing, will be

Fig. 5 A mobile cleaning and priming machine moves along the welded line removing rust and scale. Welds were checked by gamma and X-ray photography as a safeguard against breaks or leaks.

identified by an electronic gravitometer which detects gravity changes of difference in the dielectric strength of products.

Each of the four stations has two 600-h.p. 3,600-r.p.m. 2,300-volt 3-phase explosion-proof motors built in Canada. Auxiliary electric equipment takes the form of a standardised unit including switchgear, outdoor sub-station, motor control section, auxiliary control section and control desk. The two pumps at each station are four-stage, 6 in. by 8 in. by 10½ in. centrifugal pumps modified from a standard design. The pump and the motors in the pumphouse have not been separated by the usual fire wall because of the presumed safety of the explosion-proof motors. The separation of the control house from the pumphouse and the absence of liquid lines to serve pressure instruments eliminates the need for pressurising the control rooms and providing special ventilating equipment.

OPERATING METHODS

Two residences have been provided for operators at each station with the exception of the Montreal station. The arrangement is for each of the two operators to stand a 24-hour shift on alternate days. Since duties consist only of watching for batch changes and keeping the station clean the operators are free to go home when the routine does not need them. The station buildings and residences, built of buff brick, are of modern design. Communications are maintained by teletype over the Bell Company's system. Dispatching is handled from Toronto headquarters office where all movements on the line are scheduled according to a self-winding, self-correcting electric clock. Dispatching is done according to practices developed by the Shell Company operating in the United States.

All consignments are metered on receipt at Montreal and on delivery at the nine other terminals of Cornwall, Prescott, Brockville, Kingston, Belleville, Brighton, Toronto, Clarkson and Hamilton. The meters are equipped with a new type of duel Brodie motor head developed for the Trans-Northern. A lever is thrown without a clutch to select one or the other of the twin meters thus ensuring positive metering and accurate recording on the tickets. For protecting the meters against excessive wear only hay tanks are used at Montreal.

At all the terminals there are filters of a special design made by the company. At the Montreal end of the system, the three companies' refineries each deliver products to the terminal through single lines three miles long. The correct sequence of closing and opening valves is assured by the special foolproof switchboard shown in Fig. 6, opposite, designed to function uniformly under all the possible operating conditions. The operator at the pipe-line terminal manipulates the switchboard by inserting a plug in a socket. To guard against contamination, one company, on discontinuing a delivery, could be directed to pump into the three-mile delivery line a product of the same kind as that going into the line from the second company scheduled to make the next shipment. Between Clarkson and Toronto the direction of flow may be reversed as required to accommodate British American's deliveries from its refinery at Clarkson to Toronto.

The design and construction of the Trans-Northern Pipe-Line system was made under the direction of Mr. A. N. Horne, president and general manager, who supervised the building of some of the world's largest oil pipe-lines, including the war-emergency "Big-inch" and "Little Big-inch" lines from Texas to New York, the Basin System from New Mexico to Oklahoma, and the Tapline from the Persian Gulf to the Mediterranean. The Trans-Northern Pipe-Line was constructed by Mannix, Limited, Calgary and Toronto; Williams Brothers Corporation (Canada), Limited, Tulsa, Oklahoma; and Sparling-Davis, Edmonton and Toronto; Ross and Anglin, Montreal, built the pump and meter stations. The design of the project was guided by a special committee composed of members drawn from each of the three owner companies. Mr. R. W. Phillips, seconded to the McColl-Frontenac Company from the Texas Empire Pipe Line, Tulsa, acted as chief design engineer. Mr. W. B. Blank, similarly from Texas Empire, was responsible for the electrical design and continued through the construction period as acting chief engineer.

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HIGH-POWER PULSE MODULATOR

A new high-power modulator, made by Mullard Limited, Century House, Shaftesbury-avenue, London, W.C.2, is designed for generating the microsecond pulses of high energy required for operating and testing magnetrons. It can also be used with linear accelerators and in high-power radar ground stations.

The standard pattern generates two microsecond pulses with the exceptionally high peak power of 5 MW, although other pulse lengths can be obtained by using alternative delay lines. It can be triggered by an internal generator, which gives repetition frequencies of 100, 200, 350 and 500 pulses per second; and externally at any frequency between 10 and 500. The output is controlled by a continuously variable auto-transformer, which regulates the input to the three-phase mains transformer feeding the power rectifiers. The pressure of the direct-current supply thus obtained can be varied between 6 kV and 12 kV. The filament of the magnetron is supplied with a current of 9 amperes at 18 volts from a source which is built into the modulator.

Interlocks are fitted to safeguard the personnel against shocks and on the vacuum system. The state of these interlocks is indicated by lights. Protection is provided against failure of the magnetron field and filament and the cooling-water supply. If an overload occurs on the three-phase input circuit or on the main high-tension or drive circuits the supply is cut off by the appropriate relay. In addition to various meters a built-in oscilloscope provides five standard circuit checks, while spare switch positions permit the monitoring of external circuits or voltages and the connection of a 60-decibel amplifier. The time base can be triggered externally for these purposes.

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THE INSTITUTE OF MINING SURVEYORS

Amalgamation with Royal Institution of Chartered Surveyors

Approval has been given by Her Majesty's Privy Council to the terms of an agreement made between the Councils of the Royal Institution of Chartered Surveyors and the Institute of Mining Surveyors by which the latter society amalgamated with the former on December 31, 1953.

The object of the fusion is to strengthen the mining branch of the surveying profession, and it is stated that "it is confidently expected that the amalgamation will give an impetus to mining surveying generally and enhance the standard of practice in a complex field, vital to efficiency and safety in mining operations." The Royal Institution also states that "Henceforward all mining surveyors aspiring to the highest professional qualification will be required to pass the examinations of the Royal Institution of Chartered Surveyors."

SILICONE RUBBER

Resistance to Extremes of Temperature

There are many purposes in engineering for which a synthetic rubber is more suitable than the natural product, and many synthetics have been produced during the last few years. Perhaps the most recent of them are the silicone rubbers, of which one form, known as Silastomer, is now being produced in this country by Midland Silicones, Limited, 19, Upper Brook-street, London, W.1.

One of the advantages of Silastomer is its resistance to extremes of temperature. It does not begin to stiffen until about −120 deg. F. and it will withstand continuous exposure to temperatures of 350 deg. F., and intermittent exposures up to 550 deg. F. without serious damage. Being (with the exception of one grade) non-toxic and chemically inert, Silastomer can safely be used with foodstuffs. The surface will not support the growth of moulds, nor will sticky substances adhere to it. Silicone rubber is claimed to be the only one which will pass the British Pharmacopœia test for extraction with distilled water. It is swollen by some solvents (paraffins, aromatic and chlorinated hydrocarbons) but regains its original dimensions on drying out. Out of over 100 substances listed, however, there are only six for which there is not a suitable grade of this material.

ELECTRICAL PROPERTIES

Electrically, Silastomer has many advantages over organic rubber. It will withstand outdoor conditions (specimens were exposed for four years under A.S.T.M. test conditions and showed no change) and its insulating and dielectric properties are not affected by temperature changes. Even when finally decomposed at about 750 deg. F. the remaining layer is a good insulator. Its high thermal conductivity renders it suitable for the insulation of electrical machines. The insulation resistance is about 10^{12} ohms at room temperature and does not fall below 10^{11} ohms at 480 deg. F. A length of 7 mm. of ignition cable insulated with Silastomer successfully withstood a 14-kV corona test for 1,600 hours.

The properties of the material are specified in a booklet issued recently by Midland Silicones, Limited.

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SOUTH EAST LONDON TECHNICAL COLLEGE

Electronic Instruments and Process Control

Two courses on engineering subjects, each comprising six lectures, will be given during the coming months in the Department of Electrical Engineering and Applied Physics at the South East London Technical College, Lewisham-way, London, S.E.4. Lectures in the first course, on electronic instruments, will be delivered on Tuesday evenings, beginning on January 26, 1954. This course is intended as a survey of the wide range of instruments used in research and industry. The second course will relate to automatic process control and is being arranged in conjunction with Messrs. Elliott Brothers (London), Ltd., Century Works, Lewisham, London, S.E.13. These lectures will also take place on Tuesday evenings and the first will be delivered on March 9, 1954. All lectures will last for two hours and commence at 7 p.m. The fee for each course will be 20*s*. Applications to attend should be made to the head of the Department at the College.

A PRECISION X-RAY DIFFRACTION SPECTROMETER RING

CONSTANT MESHING BETWEEN ANNULAR WORM-WHEEL AND DRIVING WORM

By D. C. Barnes, A.M.I.MECH.E., and *C. Wainwright*, M.SC.

THIS article* describes a spectrometer ring which, from the engineering viewpoint, is a large annular rotatable member or ring, suitably guided by its bearing to obtain a relatively high rotational accuracy. Its design has been governed by the principles of simple kinematical mechanisms and its construction is robust. The purpose of the spectrometer is to aid in the development of Geiger-Müller counter X-ray diffraction techniques. The instrument has now been in operation in the Metallurgy Division of the National Physical Laboratory for a sufficient time for its satisfactory performance and adaptability to be demonstrated.

The design was based upon the following requirements : –

(i) To have a central aperture of sufficient size to admit bulky specimens, supports and specimen enclosures, such as a vacuum furnace of the type used when measurements are required upon specimens maintained at high temperature.

(ii) To have no restriction within the central aperture that would limit the vertical dimension of specimens or specimen holders.

(iii) To be sufficiently strong for the X-ray tube, Geiger-Müller counter and auxiliary equipment to be rigidly supported without causing appreciable distortion of the spectrometer ring, particularly when changing their relative positions by motion of the rotatable member.

(iv) The rotatable member to have a flat, unobstructed top-surface to facilitate the mounting of auxiliary apparatus.

(v) The rotatable member to carry a scale divided into degree and half-degree intervals ; this scale to be sub-divided by a graduated drum mounted upon a worm drive-shaft so that angular settings of the ring may be readily observed.

(vi) The accuracy of the worm and worm-wheel drive and the form of bearing for the rotatable member to be such that the spectrometer ring shall have an overall accuracy of angular setting of $\pm$ 20 seconds of arc at any position of the rotatable member throughout 360 degrees.

(vii) The rotatable member to be driven by hand, or by motor, at speeds of one revolution in 3, 6, 12 or 24 hours, and to be designed with a view to incorporating additional rotational or setting devices in the future.

(viii) A drive to be provided to enable specimens, mounted upon apparatus situated within the central aperture, to be rotated about the axis of the rotor at half rotor speed.

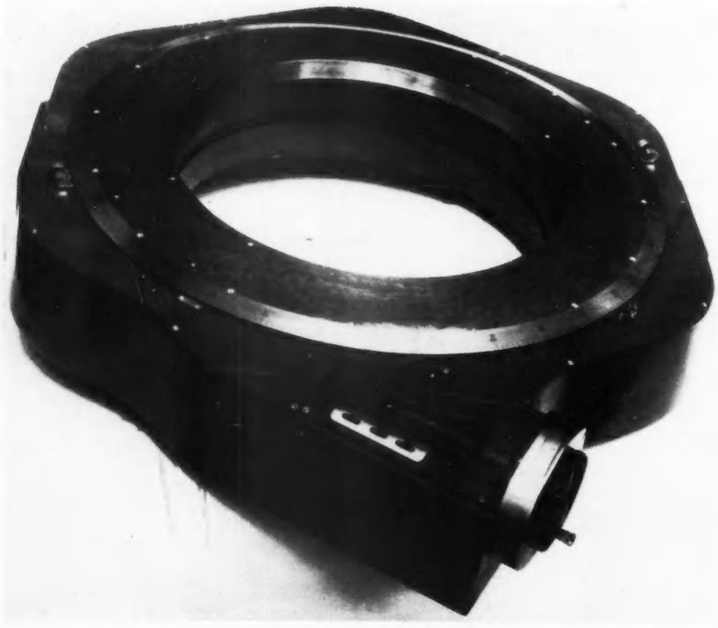
* Communication from the National Physical Laboratory.

STATOR AND DRIVE ASSEMBLY

A photograph of the complete instrument is shown in Fig. 1. The base unit and drive assembly are illustrated in Fig. 2. The instrument consists of two main elements, the stator, or base *a*, and the rotor or worm-wheel *b* (Fig. 3), both having a central circular aperture 14 in. in diameter. The hexagonally-shaped bronze base which forms the body of the instrument has large machined surfaces on four of its outer facings for mounting the X-ray tube and other stationary equipment. An inner horizontal circular facing, which is machined flat and parallel to three pads, or feet, cast on the underside of the base, provides a mounting surface for the bronze ball-track ring *c*. The outer track retains 16 (Fig. 2 shows a unit with 13) $\frac{1}{2}$-in. diameter hardened steel balls *d* which run on its flat bottom surface. Close-fitting holes in the brass disc-ring *f*, which is supported on hardened-steel balls *e* of $\frac{1}{16}$ in. diameter, retained by the inner 90-deg. V circular track, serve to space the larger balls at 22$\frac{1}{2}$-deg. intervals around the outer track. As the $\frac{1}{2}$-in. diameter balls freely support the rotor, they and the disc-ring would be expected to travel at half the speed of the rotor. A driving pin *g*, screwed into the disc-ring and protruding into the central aperture of the spectrometer ring, transmits this motion to the central specimen holder.

KINEMATIC ROTOR BEARING

Three machined recesses, situated over the feet of the instrument, house hardened and ground steel blocks *h*. The block h_1 is constrained to move radially and, under the pressure of spring *j*, provides the force closure in the kinematically-designed rotor bearing, formed by the other two rigidly fixed blocks. The grub screw *k* is provided for adjusting the spring force. The fixed block h_2, situated between the worm-shaft bearings *l*, is set at a specific distance from the worm axis, so that, provided the cylindrical bearing surface of the rotor is concentric with the imaginary pitch circle defined by its teeth, a constant condition of tooth meshing is assured, regardless of any out-of-roundness of the rotor due to possible distortion after machining. After rough machining, the top face of the bronze rotor was clamped to a lathe face-plate and lightly machined over its cylindrical bearing surface, circumferential tooth-blank surface, bore and ball-contacting face. This ensured



Figs. 1 and 2 Precision X-ray diffraction spectrometer ring, developed by the National Physical Laboratory, capable of accuracies of rotation of $\pm$ 20 seconds of arc. Fig. 2 shows the base unit and drive assembly. A series of $\frac{1}{2}$-in. diameter hardened steel balls, running on a ball-track ring mounted in the base unit, freely support an annular rotor, or worm-wheel. Three hardened and ground steel blocks constitute a kinematically-designed bearing for the rotor, ensuring a constant condition of meshing of the teeth of the driving worm and worm-wheel.

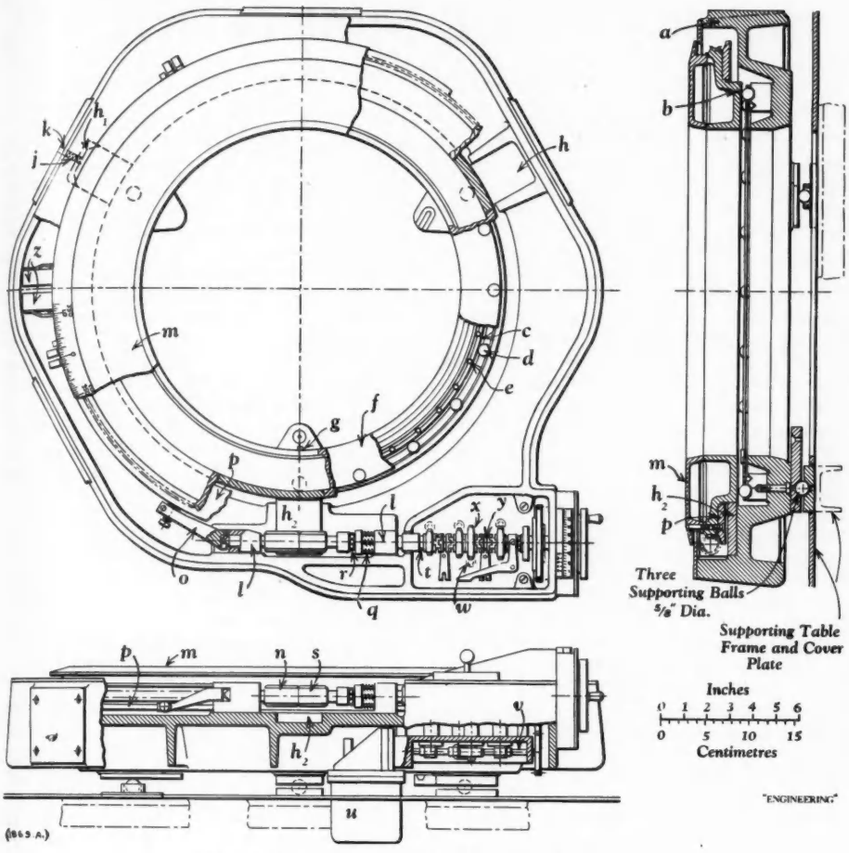


Fig. 3 General arrangement of spectrometer ring.

that its cylindrical surfaces were co-axial and its facings square to this axis.

The 720 teeth on the rotor or worm-wheel were cut to conform with a 20·835 in. diameter pitch circle, thus giving a tooth-pitch of 0·0909 in. to mesh with a worm having 11 threads per inch. The teeth were cut by the British Thomson-Houston Company, Limited, on a Gould and Eberhardt wheel-hobbing machine which has a 5-ft. diameter master worm-wheel. Fig. 4 shows the cumulative pitch errors of the worm-wheel teeth, as measured in the Metrology Division of the Laboratory. It will be noted that the errors of the worm-wheel are comfortably within the limits of ± 0·001 in. which is equivalent, at a pitch circle radius of about 10 in., to an angular error of ± 20 seconds.

The cover-casting *m* provides an unobstructed top-surface for mounting the Geiger-Müller counter tube, etc. A scale, graduated into 720 equal angular divisions of ½ deg., is marked upon the chamfered surface around the periphery of the top face of the cover casting.

TOOTH-SPACING ERRORS

Provision is made for automatically compensating for errors in the spacing of the teeth round the worm-wheel. This is effected by controlling the axial position of the driving worm-shaft *n* by the 20-to-1 lever *o*, the long limb of which bears radially against the correcting ring *p* concentrically located on the worm-wheel. Contact between the end of the worm and the lever, and between the lever and the compensating ring is maintained by thrust-springs *q* through thrust ball-race *r*.

By suitably profiling the periphery of the ring *p*, in relation to known errors in the spacing of the worm-wheel teeth, the driving worm can be made to move tangentially to the left or right to compensate for those errors. An error of 0·001 in. in the spacing would require the radius of the ring to be altered by 0·020 in.

A secondary worm *s*, spring-loaded axially on the worm shaft, eliminates possible tooth backlash. The drive-shaft *t* is connected to the worm-shaft by a co-axial housing forming an end bearing. A cross-pin pressed into the housing engages with a closely-fitting slot in the end of the worm-shaft, and although rotational motion is transmitted, one shaft is free to move axially with respect to the other. A 4-in. diameter drum, rigidly fixed to the end of the drive shaft, has a scale of 90 equal divisions marked around its periphery, so that every division is equivalent to 20 seconds of rotation of the rotor. They can be sub-divided to 5 seconds by a vernier.

SPEED-SELECTION MECHANISM

The driving mechanism was constructed as a sub-assembly so that it could be satisfactorily adjusted as a unit before it was mounted in the spectrometer body. The mechanism comprises a $\frac{1}{20}$-h.p. Evershed and Vignoles reversible synchronous motor *u* running at 3,000 r.p.m. and driving, through a spiral gear and coupling, a layshaft *v*, the axis of which lies below and parallel to the drive-shaft. Cross-shafts *w*, with worms and worm-wheels fitted to their upper and lower ends respectively, transmit the driving force from the layshaft to the worm-wheels *x* which are free to rotate on the drive shaft. Dog-clutches *y*, keyed to the drive shaft but free to move axially into engagement with the appropriate worm-wheel, select the required speed ratio. There are four double worm-train drives with reduction ratios of 750 to 1, 1,500 to 1, 3,000 to 1 and 6,000 to 1, producing rotor speeds of 1 deg. in ½, 1, 2 and 4 minutes, respectively, which correspond to one revolution in 3, 6, 12 and 24 hours. A clutch-operated two-to-one reduction spur gear-train enables the motor, when required, to drive the rotor at 2 r.p.m. A speed-change and clutch-operating lever protrudes through an aluminium-alloy cover-casting and gate, thus ensuring that one worm-drive only can be selected, and that no jamming of the worm and worm-wheels can occur.

Two micro-switches *z*, housed within the body of the circle, and coupled to the electrical motor circuit serve, when actuated by adjustable stops fitted to the periphery of the cover plate, to stop the motor at any desired angular position.

SUPPORT TO GUARD AGAINST TEMPERATURE CHANGES

The instrument is kinematically supported upon three ⅝ in. diameter hardened-steel balls positioned beneath the bearing blocks by pairs of coned, V- and flat pads. The lower pads are mounted on a welded angle-iron framework forming a table. The upper pads, fixed underneath the body of the spectrometer ring, project inwards into its circular aperture. The upper projecting surfaces of the upper pads have either a cone, V, or flat corresponding to the cone, V or flat on the lower surfaces and form a kinematic support for the specimen holder. This holder usually has a cylindrical reference surface machined concentric with its axis, and is provided with a simple horizontal adjustment upon its supporting base-plate. By using a dial-indicator mounted upon the rotor and contacting the cylindrical reference surface of the holder, the axes of the rotor and specimen may be brought truly into coincidence.

The body and the circular members of the spectrometer ring were cast from the same melt

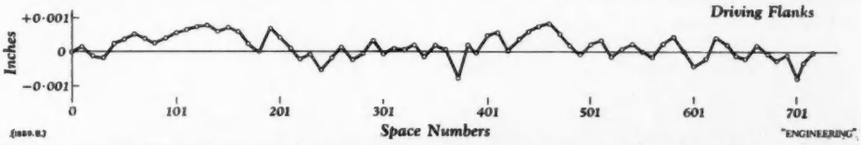


Fig. 4 Cumulative pitch errors of the worm-wheel teeth ; the worm-wheel, of 20·835-in. pitch-circle diameter, has 720 teeth, and meshes with a worm having 11 threads to the inch.

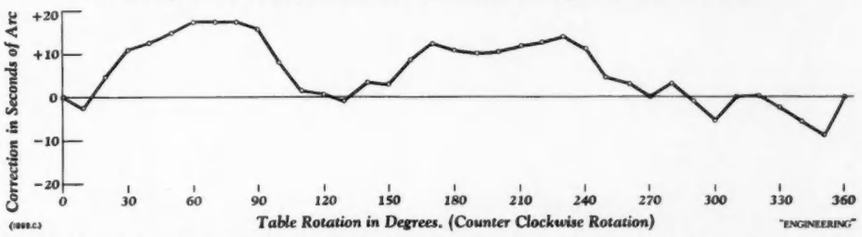


Fig. 5 Corrections to be applied to the angular readings of the table of the X-ray spectrometer ring to give the actual angles relative to zero.

to ensure that they have the same coefficient of expansion, so that temperature changes do not noticeably affect the accuracy of functioning.

On completion of its construction in the Metrology Division workshop, the instrument was tested in the gauge room. The top-surface of the cover-casting was found to rotate satisfactorily between two imaginary planes, perpendicular to its axis of rotation and only 0·0012 in. apart. The accuracy of the angular readings of the worm and worm-wheel was tested at 10-deg. intervals and the results obtained are shown in Fig. 5. It will be noted that the errors found were within the specified limits of ± 20 seconds of arc, without having to resort to radially contouring the cylindrical correcting ring *p* (Fig. 3).

The half-speed specimen drive was found to rotate to within an accuracy of 3 minutes of arc when the rotor was rotated clockwise and counter-clockwise 20 times to occupy positions at ± 60 deg. from a fixed index line.

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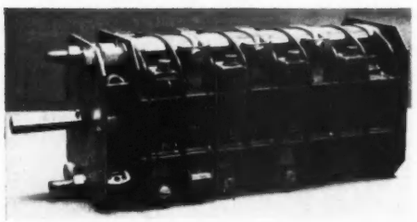

MULTI-POLE ROTARY SWITCH

Control of Machine Tools

Brookhirst Switchgear, Limited, Chester, are producing the new multi-pole roller-contact rotary switch illustrated above. It is intended for use as an " on-load " main current switch for individually driven machine tools, particularly for controlling the forward and reverse running of motors and for pole-changing on two, three or four-speed machines.

As will be seen, the switch is of compact construction and is normally supplied for mounting on the back of a panel. It has dumb-bell shaped moving contact rollers, which in the " on " position bridge a pair of fixed contact strips and thus provide a double break. The rolling action of the contacts ensures that their faces are kept clean and that the wear is evenly distributed. There are four operating positions.

The switch is made in two sizes with current-carrying capacities of 30 and 60 amperes at 550 volts, both alternating and direct current. The breaking capacities are, however, much higher than these nominal ratings.

OIL BURNER OF HIGH EFFICIENCY

FUEL - AIR RATIO AUTOMATICALLY MAINTAINED UNDER VARYING LOADS

Most low-pressure air-atomising oil burners employ separate controls for oil and air adjustments and, as a consequence, inefficient combustion frequently results over part of the working range of the burner due to inexperience of the operator. By combining these two adjustments into one control, this disadvantage can be partially reduced as long as provision is made for altering the proportions of air and oil to cater for different grades of oil. With the present high cost of fuel and skilled labour, it is more than ever necessary to provide equipment which is able to eliminate waste with the minimum of attention.

In the sectional view below it will be seen that the air entering the burner is split into two flows: the primary flow used for atomising the fuel and the secondary for completing combustion. The primary air, to which a swirl has been imparted by the vanes, is expanded through an annulus and passes the oil nozzle at high velocity. The oil leaves its nozzle radially, in the form of a " sheet " about 0·006 in. thick, at right-angles to the primary-air flow, and is thereby torn into very fine ribbons which break up into myriads of droplets. As this mixture of primary air and atomised oil leaves the atomising zone of the burner, it meets the secondary air with which it becomes thoroughly mixed. The secondary air is swirled at high velocity in the opposite direction to that of the primary stream and then expanded through its own nozzle to produce the very complete mixing that is essential for good combustion.

The oil is supplied to the nozzle through a metering valve consisting of a tapered groove and an oil seal. It will be seen from the drawing that the groove is machined in the oil tube ; the seal is held in an adjustable carrier, and the oil tube is also attached to the primary-air nozzle. Hence, if the oil tube is moved forward, the opening between the groove and the oil seal is narrowed, so reducing the quantity of oil flowing to the nozzle. Simultaneously, the primary-air nozzle moves forward with the oil tube and cuts down the area of flow of the secondary air. The oil tube is manipulated by a single lever, shown centrally in the photograph, working through a rack and pinion. By suitably proportioning the oil and air controlling passages, a sensibly constant oil/air ratio is obtained.

As the controlling oil seal is mounted in an adjustable carrier, the groove opening can be varied at will to suit oils of differing specific gravity, viscosity, etc. Thus, by altering the oil/air ratio adjuster, the burner can be made suitable for any commercial grade of oil, without loss of combustion efficiency. Obviously, it is not possible to calibrate this adjuster for all the known grades of oil, mainly because the air conditions vary with each installation, but with the aid of the CO_2 meter the optimum setting can easily be found during the initial installation or whenever the grade of oil is changed.

For normal operation, the air pressure at the burner should be at least 20 in. of water above that of the combustion chamber. For light oils, supplied from a gravity tank, 5 lb. per square inch is a suitable pressure, but for heavy viscous oils requiring heating, a pump with a delivery pressure of about 10 lb. per square inch is required. It is advantageous to be able to control the oil pressure to obtain the highest efficiency. The burner can be fitted for automatic control by the addition of a thermostat and a servo-system to operate the lever.

Standard sizes of the burner have ratings ranging from 1·5 gallons per hour up to one of 40 gallons per hour. If the burner is fitted into an air register, these ratings can be increased. The photograph shows a burner fitted in a test rig at the works of White's Marine Engineering Company, Limited, Hebburn-on-Tyne, who are the manufacturers. Research is being carried to determine optimum sizes and settings.

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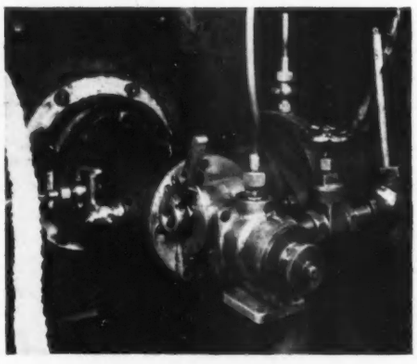
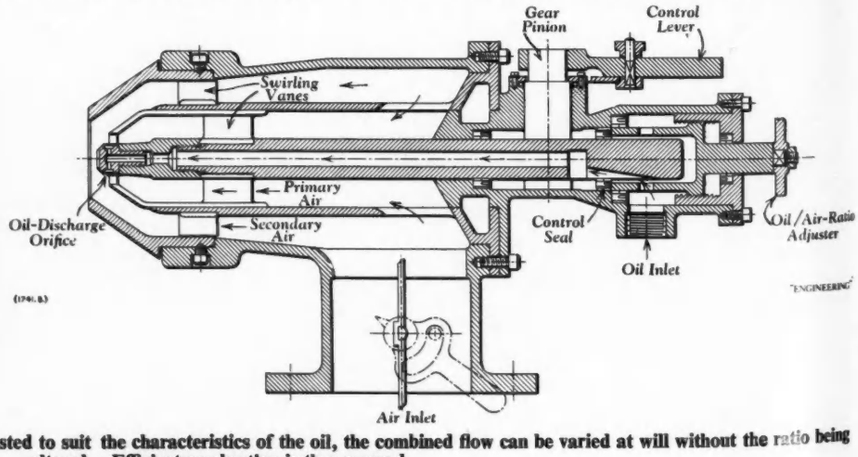
BIBLIOGRAPHY ON SHELL MOULDING

A great deal of research has been carried out and many papers and articles have been published on shell moulding, also referred to as the Croning or " C " process (from the name of its originator, Johannes Croning of Hamburg). In February, 1953, the Sheffield City Libraries issued a list of selected references to periodical and other publications on the subject of shell moulding. A revised and enlarged second edition of this bibliography has now been issued. It contains 105 references. We are informed that supplies are limited but a copy of this, No. 61, research bibliography of the Sheffield City Libraries will be sent gratis to interested organisations on application to the City Librarian, Central Library, Sheffield, 1.





After the oil - air ratio of this burner has been adjusted to suit the characteristics of the oil, the combined flow can be varied at will without the ratio being altered. Efficient combustion is thus assured.

MOBILE POWER RECTIFIER FOR AIRFIELDS

COMPENSATION FOR VARIATIONS IN MAINS VOLTAGE

The ground maintenance and testing of aircraft and the provision of power for starting jet engines should be facilitated by the use of a mobile power rectifier which has been introduced by Salford Electrical Instruments, Limited, a subsidiary of the General Electric Company, Limited, Kingsway, London, W.C.2. As much of this work is necessarily carried out in fuelling areas care has been taken that the electrical equipment offers no undue fire risk.

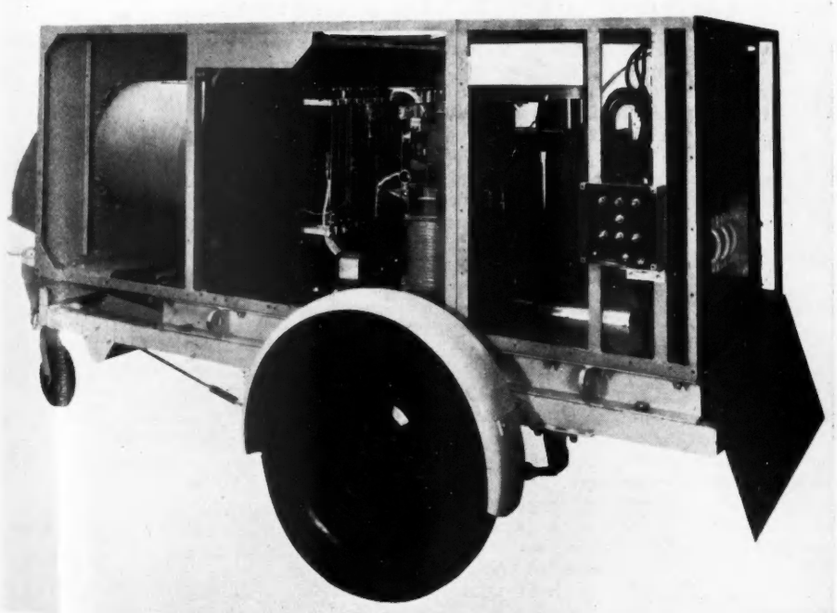
A fan which drives cooling air through the equipment is mounted at the front end of the chassis with the rectifier stack immediately behind its cowling. Behind this again are the output 'bus-bars, the main and auxiliary transformers and the smoothing choke, at the rear of which is a plate for deflecting the air through louvres at each side of the equipment. At the back and mounted on a welded frame is a panel carrying the fuses, switchgear, thermal cut-outs, control gear and change over links, the whole being suspended on anti-vibration mountings to reduce shock.

The panel is divided into two horizontally hinged parts to facilitate access to the switchgear and wing, and is protected from the weather by doors of the rear as can be seen in the illustration below. The whole of this equipment is mounted in a frame which is mounted on the chassis of a two-wheel trailer, and it can be lifted as a single unit by removing eight fixing bolts. The trailer is provided with a third retractable wheel for manœuvring. There is also a towing eye.

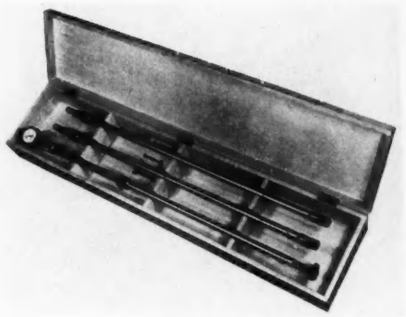
Both the mains and auxiliary booster transformers are double-wound. The primary of the former is designed for connection to either a 200/240-volt or a 400/480-volt supply, separate terminals, change-over links and control gear being provided for this purpose. It has a star-connected primary with six auto-transformer tappings, any one of which can be connected to the primary of the booster transformer. The ratio of the latter is such that it provides a voltage of about 5 volts when its primary is connected to the maximum tapping on the main transformer, the other five tappings giving 4, 3, 2, 1 and zero volts. The secondary windings of the main transformer are connected in open delta, the secondaries of the booster transformer being interconnected with them to form a full delta winding. This arrangement enables the three-phase input voltage to the rectifier to be varied in six equal steps between 22·5 and 27·5 volts and the output voltage by about $\pm$ 10 per cent. of the nominal direct-current output voltage of 28 volts.

The delta winding first mentioned is connected to a three-phase bridge-connected selenium rectifier, the continuous output rating of which is 1,000 amperes at 28 volts, while the short peak-period loading is 2,000 amperes. It is forced-air cooled by the fan and is protected both against failure of the fan and against overheating. To reduce the ripple to less than 2 per cent. at full load a choke is connected in the direct-current output circuit. The equipment is protected by fuses, thermal overloads and Klaxon thermostat switches to prevent damage by an accidental overload.

Control is effected by contactors which are operated by a push-button switch and by a six-position switch which enables the output voltage to be adjusted over a 20 per cent. range of the nominal, thus compensating for variation in the mains voltage and for drop in the connecting cables.



This mobile power rectifier provides direct current at 28 volts to facilitate ground maintenance and testing of aircraft, and to provide power for starting jet engines.



This bore-measuring gauge is provided with a compensating device which allows the pressure on the gauging plunger to be adjusted to improve the sensitivity.

ACCURATE MEASUREMENT OF BORES UP TO 8 FT. DEEP

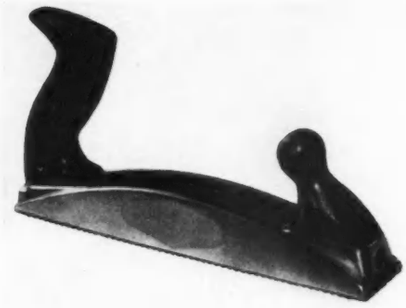
In order to provide a means of accurately checking bores of between 2 in. and 6 in. diameter at depths up to 8 ft., British Indicators, Limited, Sutton-road, St. Albans, Hertfordshire, have developed the cylinder gauge shown above. The sensitivity of the instrument is enhanced by a compensating device, by means of which the operating pressure at the gauging plunger may be controlled.

The plunger, in conjunction with a centralising shoe, registers the diameter of bore at a given depth and the reading is transmitted through a moving rod to a dial indicator. The push rod, which is of light alloy, is carried centrally in a tube and the whole unit may be extended by the addition of one or two auxiliary sections. Not only does this division into short lengths simplify transport of the instrument but measurement of bores at comparatively shallow depths may also be made more conveniently without the encumbrance of a long shaft.

Screwed ends and threaded collars enable the separate units to be connected and three lengths are therefore available. Continuous contact between the sections of the push rod is established by means of a return spring, embodied in the end of each auxiliary tube. The shoe is inserted, by means of a cylindrical extension piece, into the main or lower tube and pressed home. The dial indicator may be firmly attached to whichever section is uppermost, by means of a screwed joint, similar to those linking the three sections. A spring ensures that permanent contact is maintained between the push rod and the indicator plunger.

Although the push rod is made of light-alloy tubing, the weight of three 2 ft. 9 in. lengths is sufficient to influence the sensitivity of the instrument. In order to reduce this effect, a compensating spring, which counterbalances the weight of the push rod, is provided in the main unit of the gauge. The tension of the spring is varied by means of a collar which slides on the outer tube and, by adjusting it, response to operating resistances as low as 4 oz. may be obtained at the gauging plunger. This improves the sensitivity of the gauge and permits more accurate measurement of bores.

The total length of the gauge can be 2 ft. 9 in., 5 ft. 6 in., or 8 ft. The instrument is supplied in a case 3 ft. 6 in. long, with tools and fittings, and has been developed in the form described in this article to meet special requirements of the Department of Scientific and Industrial Research.



This hand tool, combining the functions of a plane, a file and a spokeshave, has 500 cutting edges, with an equal number of perforations to prevent clogging.

SURFACING AND FORMING TOOL

Combined Plane and File

A novel hand surfacing tool, one form (shown above) similar in appearance and function to a hand plane and the other to a file, has been developed by Firth Brown Tools, Limited, Carlisle-street, Sheffield, and is marketed by Simmonds Aerocessories, Limited, Pontypridd, Glamorganshire. Known as the Surform, the tool may be used on materials ranging from wood and plastics to copper and mild steel and has applications extending from cobbling and carpentry to the fettling of castings. The Surform is claimed to be superior to conventional tools both in versatility and in the speed at which it enables operations to be performed.

The essential part of both tools is a high-quality carbon-steel cutting strip, in which are set 500 separate blades, each at a cutting angle of 35-deg. The shavings and other waste are permitted to escape by an equal number of perforations; thus, clogging of the blades is eliminated. The cutting strip may be released by loosening a tension screw at the front of the tool and worn blades can therefore be replaced without difficulty. The shape of the blade is such that the depth of cut is strictly controlled, and handling the tool requires little skill. Furthermore, in surfacing or cross-cutting thin materials, such as plywood, the tendency to spall the edges is much reduced.

The most notable characteristic of the blade is its efficiency of operation. Tests carried out by the makers have shown that, with a given load and working speed, the Surform possesses a greater material-removing capacity than conventional hand tools. During one test, for example, carried out on copper of 1-in. square section, a load of 24 lb. was applied in turn to an engineer's rough file, a rasp and a file-type Surform. After 30 minutes and the completion of 2,400 strokes, the Surform had removed 1 $\frac{5}{16}$ in. of material, the file approximately $\frac{3}{8}$ in. and the rasp only $\frac{1}{16}$ in. When aluminium was the testing medium, the figures were 1$\frac{3}{4}$ in. for the Surform, 1$\frac{1}{4}$ in. for the rasp and $\frac{5}{8}$ in. for the file. It is estimated that, even under workshop conditions, the Surform has more than eight times the efficiency of a file when forming copper, and gives improved results with all non-ferrous metals. In the case of wood, it is claimed, its speed of working is ten times that of rasps and files.

When wood is the material being worked, the plane-type Surform is generally the more suitable tool and in such trades as joinery and pattern-making its applications are numerous. It has also many household uses. In order to maintain the quality of cut it is necessary occasionally to change the blade.

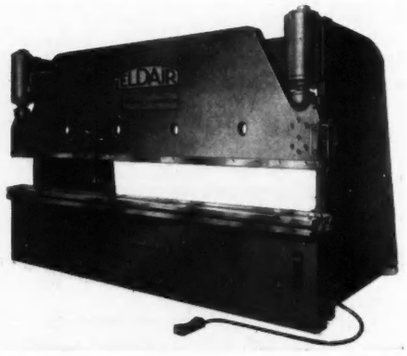
PRESS BRAKE OPERATED HYDRAULICALLY

Full Pressure throughout Stroke

The "Eldair 10/140" hydraulic press brake shown in the illustration below has recently been introduced by Weldall and Assembly, Limited, Stourbridge, a member of the Triplex group of companies. It is self-contained and the motor, oil tank, hydraulic pumps and other equipment are mounted high up in the crown of the machine.

The load is applied directly by two hydraulic cylinders, which can be seen in the illustration. By this means the use of a crankshaft, gears and linkage mechamisms has been eliminated. The advantages of hydraulic operation are simplicity of design and the fact that the full working pressure is available at any part of the stroke. The rated capacity of the machine is 140 tons, and it is suitable for forming mild-steel sheet not exceeding 10 ft. long by $\frac{1}{4}$ in. thick. The forming capacity using the overall length of the die is 12 ft. by $\frac{3}{16}$ in.

For the protection of the machine a pressure-operated switch has been incorporated in the



The use of two hydraulic cylinders in this 140-ton press brake eliminates the usual crankshaft, gears, etc., and provides the full working force throughout the stroke.

hydraulic circuit to ensure that the pressure in the system is unable to build up beyond the full pre-set load, so that breakages caused by jamming or overloading due to faulty setting of the tool are practically impossible. The ram can be stopped or reversed during any part of the stroke. To assist in setting the desired length and position of the stroke, limit switches have been fitted and a control switch enables either single-stroking operation or continuous running to be selected. On single-stroking, when the pedal which can be seen in the illustration is depressed, the ram closes until the top limit switch is reached, then it automatically reverses to the bottom limit switch and stops. When set for continuous running, the ram will oscillate between the top and bottom limits while pressure is maintained on the foot control, but immediately this is relaxed the ram stops.

The frame, bed and ram are of welded construction, fabricated from steel plate and designed to keep deflection to a minimum. A clear space between the housings at the back of the machine facilitates handling of the work. The hydraulic cylinders are cast in steel and are located and bolted directly on to the housings, arranged so that centre-line loading is assured and distortion due to eccentric loads is prevented. The long V-slides have gib strips on both sides for adjustment.

The distance between the frames is 10 ft. 6 in. and the overall die space is 12 ft. The standard stroke of the ram is 6 in. The throat clearance from the centre-line of the dies is 10 in. and the die space when the ram is raised is 15 in. A pressing speed of 0·66 in. per second can be obtained in normal operation and the return speed is 3·80 in. per second. The weight of the complete press is about 9$\frac{1}{2}$ tons.

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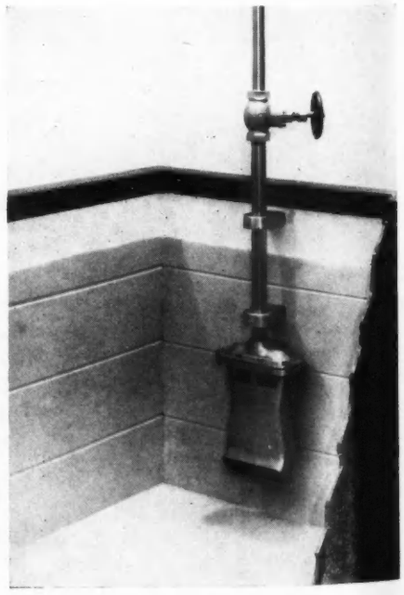
HEATING LIQUIDS DIRECTLY BY STEAM

Ejector Design Improves Flow

The steam heater shown below, for installation in tanks and vats containing fluids, has been developed by Ward's Patents, Limited, Old Colony House, South King-street, Manchester, 2, and is manufactured in three sizes for connecting to $\frac{3}{4}$-in., 1-in. and 1$\frac{1}{2}$-in. steam mains. The material from which it is made is an acid-resisting alloy and for this reason the makers suggest that it should be of particular interest to the dyeing and chemical industries or for any other process where liquid is heated by steam. As can be seen from the illustration, it is simply installed and does away with the need for the more common coil of piping around the sides.

The heater is designed on the principle of the ejector. The large nozzle is shaped to form a Venturi and a number of steam tubes extend from the head of the heater to the neck of the Venturi. When the steam supply is turned on it issues from the tubes into the diffuser passage of the nozzle, drawing water through the slots above, which can be seen in the illustration, and ejecting it together with the steam from the nozzle. The outlet from the nozzle is curved forwards so that the flow is directed along the bottom of the tank. The heater comprises two main pieces: the nozzle and the steam head with attached steam tubes. The two parts are bolted together and sealed by a gasket.

The unit is known as the rapid tank heater and is said to promote more rapid mixing and circulation than has been achieved previously. It is silent in operation. At a recent test carried out in a dye works the heater showed a steam saving of approximately 10 per cent. over the previous method which made use of perforated steam pipes. The time required to heat the vat was reduced by 20 per cent.



The ejector design of this heater allows steam to mix thoroughly with the liquid being heated.

MICROMETER WITH SETTING SHOWN NUMERICALLY

The "Micromaster" micrometer, which has been developed by Tesa, Limited, Renens-Lausanne, Switzerland, goes a long way towards solving the difficulties sometimes experienced in reading micrometers. As can be seen from the illustration below, it is similar to a normal micrometer, but the divisions are more widely spaced and the setting is indicated by numerals.

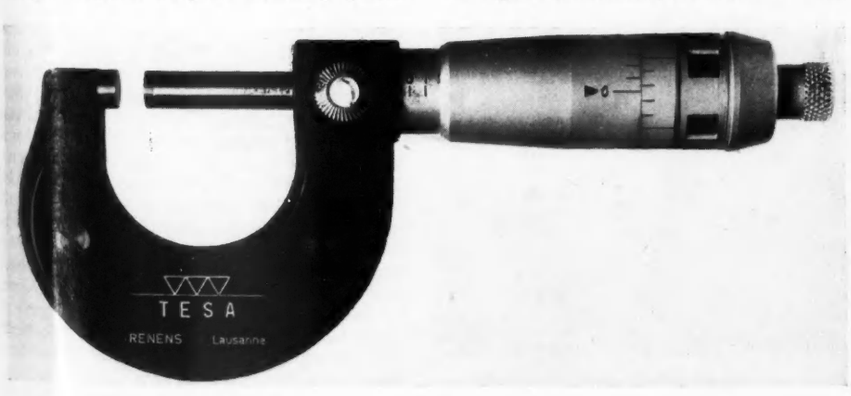
The instrument is used in the same manner as a standard micrometer and it incorporates the normal locking screw on the head and the ratchet knob at the end of the spindle. The main barrel is graduated to read in 0·1 in. The figures in the apertures show the 0·01 in. and 0·001 in. measurements in steps of 0·005 in. of axial movement, and between adjacent apertures the thimble is graduated in 0·001 in. ; thus the maximum figure that must be added to the reading in the aperture adjacent to the arrowhead is 0·004 in. The left-hand portion of the thimble has a Vernier scale for reading to 0·0001 in. A feature of the scales on the two halves of the thimble is that they have both been arranged in the same plane to prevent parallax errors. The instrument illustrated is set at 0·1827 in. ; due to the position of the sleeve in the illustration it is not possible to read the final figure, but it can be seen that the Vernier scale begins at the zero in front of the arrowhead.

To adjust the instrument, the right-hand end of the thimble is rotated. The left-hand portion does not rotate but merely slides along the main barrel, rotation being prevented by a key which fits in a groove cut along the face of the barrel. The numerals, which appear in white on a black background in the apertures, are part of a small calculating machine comprising five planet wheels each of which is attached to the end of a drum carrying four sets of figures, The first drum, for example, is numbered 0, 25, 50 and 75. An epicyclic gear is arranged to transmit a few degrees of movement to the sun wheel of the system sufficient to move the planet wheels one quarter of a turn for each complete revolution of the thimble.

To enable the zero to be reset an adjusting screw has been provided ; this is placed at the end of the thimble beneath a removable cap. Once it is loosened the thimble can be set to any position desired.

In place of the slotted guide nut fitted to micrometers for taking up the slack in the longitudinal movement of the measuring spindle a fresh arrangement has been chosen. It incorporates a guide nut with an adjusting nut screwed on to the open end, both these pieces being threaded to carry the measuring spindle. The thread by which they are held together is of a different pitch from that on the spindle so that slackening of the adjusting nut causes a thrust to be exerted upon opposing flanks of the spindle thread; this is similar to the principle behind the use of two lock nuts. In practice the pressure exerted upon the nose of the measuring spindle forces it back on to the flanks of the thread in the guide nut and the adjusting nut is slackened off until it contacts the opposing flank of spindle thread to remove any end play.

The measuring surfaces of the spindle are carbide-tipped and the finish of the instrument is dull chromium-plate and black enamel. It is made in four sizes, 0 to 1 in., 1 to 2 in., 2 to 3 in., and 3 to 4 in., in both hand and bench types. The sole distributors for the Micromaster in this country are the Adam Machine Tool Company, Limited, 4, Grange-street, St. Albans.



The numerals and the clearly marked divisions on this micrometer simplify reading.

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SELF-REGULATING ALTERNATOR

Output Voltage controlled without Automatic Regulator

The self-regulating alternator which Messrs. Crompton Parkinson, Limited, Aldwych, London, W.C.2, are now manufacturing, is designed so that its output voltage can be controlled without the use of an automatic voltage regulator. It is made for outputs up to 115 kVA at 500 volts and 1,500 r.p.m. and is constructed so that it can be operated by semi-skilled attendants and maintenance thus reduced to a minimum. Its inherent voltage regulation is $\pm 2\frac{1}{2}$ per cent. at any load and at any power factor between unity and 0·75 lagging.

The unit, as can be seen from the illustration, consists of a revolving armature machine and a Magnicon exciter, which is so arranged that a small change in the direct-current voltage applied to a control pole produces a relatively large change in the flux from the main poles. The direct-current voltage is derived from a metal rectifier, the primary of which is supplied from the alternating current circuit through a trimming resistance and a voltage setting regulator, and is applied to the control pole. This pole is so designed that any change in the alternating current voltage results in an automatic adjustment of the relative values of two magnetic fluxes. The resultant changes then automatically produce a variation in the alternator field current and therefore of the voltage.

As regards construction, the exciter is of the two end-shield type and is mounted on pillar supports on the top of the alternator. It is driven by enclosed V-belts, the tension of which can be altered, from a short shaft extension and its armature runs in ball and roller bearings. The field system is fully laminated, thus ensuring rapid response to changes in the alternating current voltage and is provided with a distributed compensating winding.

The field, which is energised from the rectifier, causes a current to flow round the closed circuit formed by the short-circuited connection across one set of brushes. This circulating current in turn sets up an armature reaction which produces a second field at right angles in space to the original control field. The current generated by this second field is collected by a second pair of brushes set at right angles to the first pair and is fed into the alternator field. The armature reaction, which is produced by the output current, is cancelled by a compensating winding carried in additional slots in the pole faces of the exciter. It does not therefore interfere with the original control field.

As the controlling power required is small it is convenient to make the control field of the exciter equal to the difference between two stronger fields acting in opposition. These fields are wound on the same poles, one being magnetically saturated and therefore practically constant, while the other is unsaturated and varies in strength with the alternator voltage. These fields balance when the alternator voltage is correct, but if it falls a difference occurs which is magnified by the action of the exciter, thus producing sufficient output to restore the alternator voltage to its original value.

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SLIDE RULE FOR TUBE CALCULATIONS

To facilitate the calculations required in connection with tube making, deep drawing, bar rolling and drawing, wire-drawing, extrusion and other methods of forming metal sections or products, a special slide rule has been designed by the Department of Development and Research of Tube Investments, Limited, Plume-street, Aston, Birmingham, 6.

The rule is of normal construction and has four fixed and three sliding scales which, used individually or conjointly, enable calculations relating to percentage reduction, percentage elongation corresponding to a given reduction in area, numerical gauge values and thicknesses in inches, cross-sectional areas, thicknesses and weights of tubes and other similar arithmetical work to be carried out easily and accurately. Two of the scales are of the usual logarithmic type, so that they can also be employed for ordinary arithmetical work. A particularly clear instruction book, of which Mr. Lloyd Bethell is the author, is issued by the Departmen.

MOBILE ELECTRICAL TESTING LABORATORY

To overcome the obstacles of testing on remote sites, to which the transport of delicate scientific instruments may be difficult and where space may not be available for setting up the apparatus under shelter, the English Electric Company, Limited, Kingsway, London, W.C.2, have designed a mobile testing laboratory. It consists of a towing vehicle and trailer in which the equipment can be loaded.

The apparatus includes a specially built high-potential testing set and cathode-ray and Duddell oscillographs. The latter can investigate up to six traces simultaneously and record them on continuous-drum and roll film, which can then be developed in a darkroom. Other photographic equipment includes a quarter-plate camera ; a 16-mm. cine-camera, taking up to 64 frames per second ; a 16-mm. projector, for showing film at speeds as low as two frames per second ; and a manually-operated projector, by which the individual frames can be investigated on a ground-glass screen. It is thus possible to record on site the transient and recurring phenomena of electrical machines and circuit-breakers as well as to measure and analyse noise and vibration. Provision is also made for high-voltage testing.

The necessary supplies of power for test purposes can usually be obtained on site through a cable which, when not in use, is carried at the rear of the trailer under the work bench. An earthing cable, which is connected to a copper strip running under the floor of the trailer to the test equipment, is carried in the same position and can be coupled to the apparatus under investigation or to a convenient earth. There is also a hose, which can be connected to the local water mains and used in conjunction with an electrically-driven pump to fill two tanks under the floor. The bench has drawers and cupboards for tools and the trailer is equipped with thermostatically-controlled heaters to counteract condensation.

TELEVISION IN INDUSTRY

EDUCATIONAL AND COMMERCIAL

Until comparatively recently few uses had been found for television outside the realm of entertainment, chiefly because of the high cost and lack of portability of the equipment. About two years ago, however, Messrs. Pye, Limited, Cambridge (after some more or less experimental apparatus had been employed in one or two hospitals), installed a miniature camera for relaying information between a banking firm's provincial premises and its London headquarters. This was so successful that the development of an industrial television unit was undertaken. One of these sets has been installed for teaching purposes at the National College of Rubber Technology, Holloway, and experience has also been gained with it in a number of branches of industry and commerce. The result seems to indicate that this method of communication has great possibilities in many directions.

As will be seen from the illustration on the right, equipment for the generation and control of the television image is very compact, being contained in a single case measuring only 16⅜ in. by 6½ in. by 14 in., and weighing 31 lb. All the components are carried on a single chassis unit, which is mounted vertically between the front and rear panels of the camera. This chassis also acts as the mechanical framework and its strength has been designed accordingly.

The camera tube, which is of the Cathodeon Staticon miniature type, is 6 in. long and 1 in. in diameter. It operates on the photo-conductive principle as distinct from the photo-emissive principle, which is used in most television cameras, and during manufacture was subjected to a number of mechanical tests as well as being checked for resolution capabilities, colour response and visual sensitivity. It is installed near the base of the unit and is mounted inside

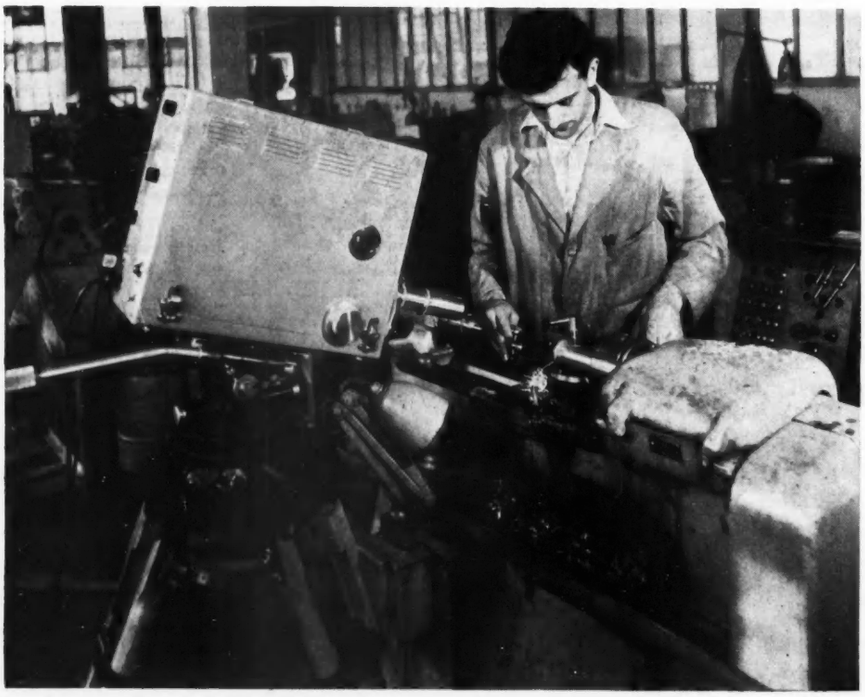
High-definition television camera for industrial and educational purposes.

the deflection, focusing and alignment coil assembly whereby the scanning of the electron beam is controlled. A small photo-sensitive target at the front of the tube receives the optical image, which is transmitted by one of the three turret-mounted lenses.

The pick-up tube and coil assembly are fixed on a carriage which can be moved backwards or forwards by turning knobs on the side of the case, thus operating a rack and pinion system through twin epicyclic gears and enabling very accurate focusing to be obtained. The power supply components are accommodated in the lower part of the chassis with the video amplifying, scanning and pulse generating circuits above. In arranging the layout of these parts considerable attention was directed to simplifying the circuitry. The result is that only 23 valves are employed for the manifold purposes of scanning, video amplification, pulse generation to a high standard and the production of an amplitude-modulated video frequency output signal, which can be transmitted to the aerial of a normal television receiver. Cooling is effected by a fan, which is installed between the two sections and the layout is such that maintenance is facilitated. The life of the equipment should, however, be high owing to the conservative ratings adopted.

The power input is about 150 watts and models are available for operation either on the 405-line British system or on the international 525-line system, the former being tunable over the British Broadcasting Corporation's channels using positive modulation and the latter from 50 to 80 megacycles with negative modulation. A high-definition 14-in. picture monitor is connected to the camera by a single coaxial cable so that information can be conveyed up to a distance of 1,000 ft. This monitor is provided with a " dark-screen " viewing filter, thus ensuring clear pictures under all ambient lighting conditions.

As already mentioned, equipment of this kind is being used in the National College of Rubber Technology, Holloway, where all the lecture rooms have been wired for television. Up to



While this turning process is being viewed by the television camera it is watched by students in a distant lecture room.

180 students can, as a result, be instructed in the use of the complicated machinery installed in the basement, as compared with the three or four who could stand round it under normal conditions. One illustration shows a camera being used to view a machining process which is being watched by a distant group of students on a 27-in. receiver.

Other suggested uses for television in industry are for viewing and thus controlling the machinery used for compressing explosives; for receiving pictures of the control panels of remotely-controlled aircraft; and for examining the interior of blast furnaces. Cameras of the type described were recently employed at the opening of the new Rolls-Royce factory at East Kilbride, to enable the test-beds to be inspected by visitors from a distance of over two miles. Mention has already been made of the employment of such apparatus in banking for the transmission of signatures and other information, while a camera installed by a newspaper organisation in Glasgow enables the " stone " sub-editor to be watched by the editor in his office. The uses of this equipment for police and advertising purposes is also practicable.

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IMPORTS OF FERRO-ALLOYS

The Board of Trade, in their Notice to Importers No. 522, announced the arrangements made for licensing imports of ferro-alloys and calcium silicide on private account. The Board have now put out a further Notice to Importers, No. 624, in which it is stated that open individual licences will be issued for imports of calcium silicide and unwrought ferro-chromium, ferro-silicon, ferro-silicon-chromium and silico-manganese, which are consigned from, and originate in, any country other than Albania, Argentina, Bolivia, Bulgaria, Canada, Colombia, Costa Rica, Cuba, Czechoslovakia, the Dominician Republic, Ecuador, El Salvador, French Somaliland, Germany (Russian Zone), Guatemala, Haiti, Honduras, Hungary, Japan, Korea, Liberia, Mexico, Nicaragua, Panama, Persia, the Philippines, Poland, Roumania, Tangier, the United States, the U.S.S.R., and Venezuela. Applications should be submitted on form ILB/A to the Import Licensing Branch, Board of Trade, 43, Marsham-street, London, S.W.1, from which further particulars may be obtained.

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ANTI-CORROSIVE COATING FOR EXHAUST VALVES

Resistance to Leaded Fuels

An 80/20 nickel-chromium alloy known as B.A.C. Brightray, which was developed during the last war by Henry Wiggin and Company, Limited, Birmingham, for coating valves of aircraft engines to protect them against the corrosive effects of leaded fuels, is being extensively employed now in the automobile industry, particularly for Diesel engines running on heavy fuels. It is claimed that a greatly extended life is obtained for valves coated with Brightray, which has a high resistance to corrosion and cracking at high temperatures, as well as affording protection against attack by leaded fuels. The cost of Brightray coating is small.

B.A.C. Brightray can be applied either as a protective coating during manufacture, or it may be used to reclaim valves which have burnt out. It is used in the form of welding wire, applied by oxy-acetylene welding to the seat, rim, and edge of the crown of the valve after the latter has been suitably prepared. No flux is required and, providing that the flame setting is maintained, a reasonably experienced welder should have no difficulty in obtaining satisfactory deposits. The deposit can be machined close to size on an ordinary lathe, and the only grinding required is a surface-finishing operation on the seat face. The accompanying illustration shows an installation for coating large valves and inserts; the component is rotated during the process. The valve head illustrated was of H-3 steel which required to be preheated to 300 deg. C., with further treatment after heating.

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WORK CLAMP AND EJECTOR FOR GEAR SHAPER

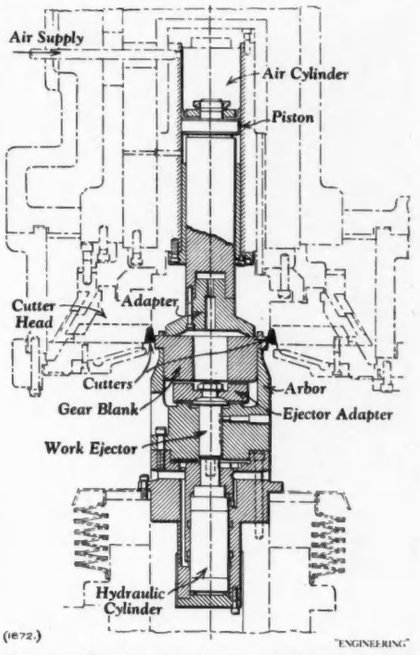
Pneumatic and Hydraulic Aid to Production

One problem which every machine-tool designer has to face is the provision of means for clamping the work-piece in position; for some tools arrangements have also to be made for ejecting the work when the operation is complete. A special difficulty is to make the devices automatic for line production work.

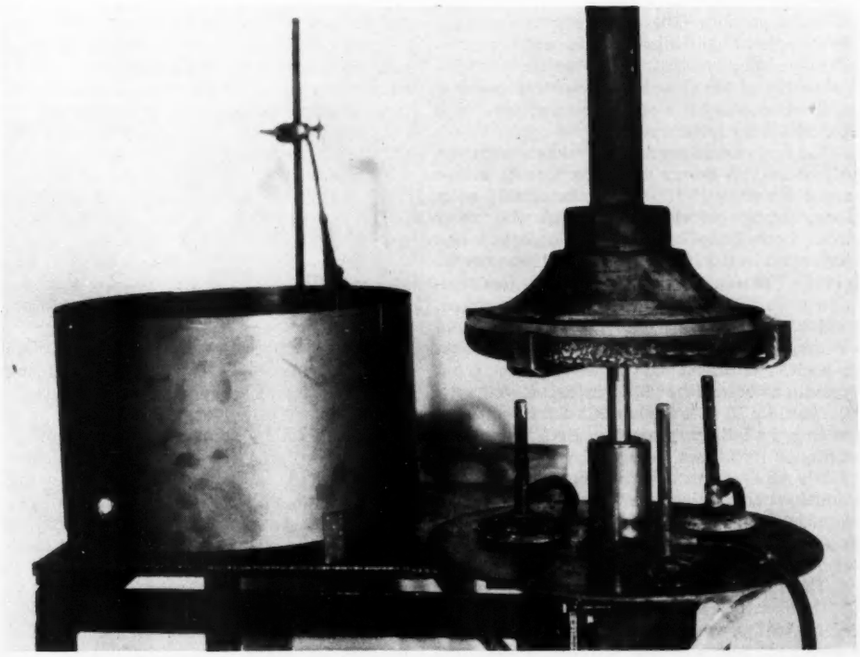
The Michigan Tool Company, 7171, E. McNichols-road, Detroit 12, Michigan, U.S.A., are now marketing clamps and ejectors for use with their " Shear-Speed " gear shapers. The illustration is a cross-section of the two devices mounted in a shaper. The clamp is automatic, but the ejector is hand-controlled.

The air cylinder and its piston which operate the clamp are mounted within the head of the shaper; air from the factory supply being used. The adaptor attached to the bottom of the piston is shaped to accord with the particular gear being cut, and, in addition to positive location of the work-piece, provides additional support for the work arbor. Thus, gears can be cut either with a hollow arbor as shown, or with an integral shaft; changing the adaptor can be carried out very quickly.

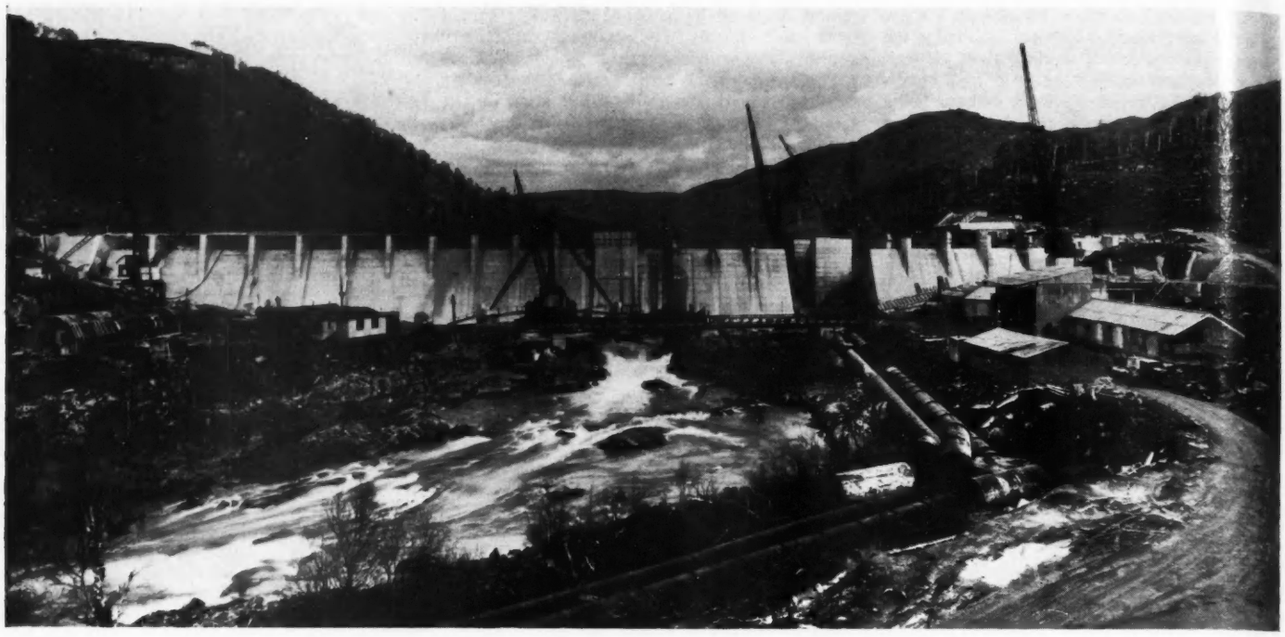
Similarly, the adaptor on the ejector can be changed to suit the work in hand. Unlike the clamp, the ejector is manually controlled and hydraulically operated. In this machine, it is the work which moves against the cutters, and the ejector cylinder is mounted in the moving ram. Admission of the hydraulic fluid to the cylinder forces the piston upwards and ejects the work-piece from the arbor. The pneumatic clamp will, of course, move up and down with the work-piece during the working stroke. One of the main advantages claimed for these devices is that there are no loose parts to be replaced whenever a new work-piece is mounted on the machine.



Cross-section showing clamp and ejector mounted in the shaper. Arbors and adaptors can be changed to suit the work-piece.



Installation for coating large valves and inserts. The component is rotated during the process, which consists of the oxy-acetylene welding of B.A.C. Brightray welding wire to the seat, rim and edge of the valve crown.



Downstream view of Luichart Dam, which is 52 ft. high and 680 ft. long.

CONON VALLEY HYDRO-ELECTRIC SCHEME

LARGEST IN THE UNITED KINGDOM

What will be, when completed, the largest hydro-electric scheme in the United Kingdom is now rapidly taking shape in Ross-shire under the auspices of the North of Scotland Hydro-Electric Board. Briefly entitled the Conon Valley scheme – though, in fact, its full extent is considerably greater – it will have an eventual output of about 440 million kWh per annum. Parliamentary authority has still to be obtained for some portions of the scheme, and the last of these portions – the Orrin project – will not be completed until about 1959; but power is already being generated by one of the five tributaries of the Conon, work on three more is well advanced, and it is hoped to proceed with the fifth in the present year.

The first part of the scheme – the construction of the 24-MW power station at Grudie Bridge and the tunnel, 10 ft. in diameter and 3¾ miles long, through which it is supplied with water from Loch Fannich – was fully described and illustrated in the 172nd volume of ENGINEERING (1951). This station, which has been in operation since 1950, contains two Francis turbines, and has supplied much of the power required in the development of the succeeding sites. At present, there is no dam at Loch Fannich, but provision for one has been made; it will raise the level by 20 ft. only, but this will be sufficient to ensure a full year's supply. Even without the dam, the loch has a storage of 62 per cent. of a year's requirements at Grudie Bridge, and additional water is being diverted to it by means of aqueducts.

WORK IN PROGRESS

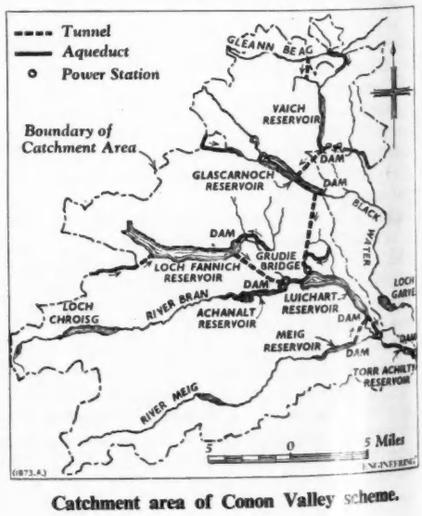
The main development in the valley of the River Conon is in the area Glascarnoch-Luichart-Torr Achilty, which will use the water from a catchment area of some 345 square miles and will produce about 290 million kWh per annum, with power stations at Achanalt, Glascarnoch, Luichart and Torr Achilty. About 1,400 men are engaged on the work, which includes, in addition to the dams and power stations, and the connecting tunnels, the construction of various new roads and also a length of railway track and a station, as the existing track will be submerged when the level of Loch Luichart is raised. A feature of the scheme is that a large proportion of the water used will pass in succession through several power stations.

To the north of the chain of power stations a dam is to be constructed across Strath Vaich to form a new loch from which water will be led to a second new loch, in the Glascarnoch valley, where there will be another dam, near Aultguish Inn. Both of these dams will be of earth and rock-fill construction, to save cement and reduce the cost of shuttering. From the second loch, a tunnel five miles in length and 10 ft. in diameter will lead the water to Glascarnoch power station, near the head of Loch Luichart. The Vaich dam will be 85 ft. high and 780 ft. long, and the Glascarnoch dam 90 ft. high and 1,690 ft. long. The tunnel connecting the two new lochs will be 9 ft. in diameter and about 2½ miles long. The Glascarnoch station will contain two 12-MW generators driven by Francis turbines operating under a gross head of 529 ft., and estimated to give an average annual output of 112 million kWh.

Above Loch Luichart, the river is known as the Bran, and the valley through which it flows as Strath Bran. About two miles upstream from Grudie Bridge there is a small loch, Loch a'Chuilinn, at the outlet of which a small barrage, 9 ft. high and 30 ft. long, is being constructed. The water thus impounded will supply the generating station at Achanalt, to which it will be led by a tunnel 9 ft. in diameter and 542 ft. long. Achanalt station is the smallest of the series, and will contain a single generator of 2-MW capacity, estimated to give 6 million kWh a year. The gross head of the station is 65 ft.

On the River Meig, which joins the Conon below the eastern end of Loch Luichart, a dam is being constructed near Curin, from which a tunnel will lead the water into Loch Luichart. Another tunnel will convey the water of the loch to the Luichart power station, situated at the confluence of the rivers Meig and Conon. The Meig dam will be 55 ft. high and 565 ft. long. The tunnel to Loch Luichart is nearly 13 ft. in diameter and not quite 1¾ miles long. It will discharge into Loch Luichart immediately behind the Luichart dam, which is 52 ft. high and 680 ft. long. The Luichart power station is similar in arrangement to that at Grudie Bridge, containing two 12-MW sets. The Francis turbines will operate at a gross head of 185 ft., and will have an estimated average annual output of 124 million kWh. The intake tunnel is 16 ft. in diameter and 4,090 ft. long.

The remaining section of the work at present in hand is that at Torr Achilty, on the River Conon, where a dam is being built which, unlike the others mentioned, has a power station incorporated in it. The two Kaplan turbines to be installed in the station will work under a gross head of 52 ft., and will drive alternators of 7·5 MW capacity each, giving an estimated



Catchment area of Conon Valley scheme.

annual output of 36 million kWh. The dam has a height of 60 ft. and a length of 570 ft., and is provided with a fish-pass of the vertical-lift type, functioning on the same principle as a canal lock. The main purpose of the Torr Achilty dam is to regulate the flow of water downstream, as the Pitlochry dam does in the case of the Tummel-Garry Scheme.

The final stage of the Conon Valley development, not yet begun, is the Orrin scheme. The River Orrin is a tributary of the Conon and lies to the south of it. The plan is to form a new lock in Glen Orrin by building a dam about five miles above the Orrin Falls. The water will be led through a tunnel to a power house in Strath Conon near Achonokie, on the southern shore of the small lock that will be formed by the Torr Achilty dam. This Scheme will have an estimated average annual output of about 74 million kWh, and a further 5,000,000 units will be gained by passing the same water through the Torr Achilty turbines, lower down the stream.

NEW ROADS

The work that the North of Scotland Hydro-Electric Board is doing in these remote and sparsely populated areas, and the benefits that they are bringing to the region, is by no means confined to the construction of fixed plant and the distribution of electricity. In the area covered by the Conon Valley Scheme they have constructed or are supporting the construction of 53 miles of road, at a cost of about £500,000, making about 100 miles of public roads on all their Schemes.

By the use of local stone wherever possible, they have done a great deal to revive the declining craft of the stonemason. Four of the power stations mentioned above are being built of Tarradale, quarried near Muir of Ord, and stone is being used also for the new control station at Fort Augustus. At Loch Quoich, in Glen Garry, they have now 45 masons and a dozen apprentices at work, which represents a considerable revival.

The Board have also been able to improve the fishing materially by organised measures to clear the lochs of predatory fish. In Lochs Luichart, a'Chuilinn and Achanalt, in 1952, 1,306 pike were caught, and a further 2,264 (which were observed to be of much smaller size) in 1953. In 1952, also, 21,329 perch were caught, and 8,205 in 1953. A salmon hatchery has been established near Contin, and the developments are opening up a long stretch of the River Glascarnoch to salmon, which previously the fish could not reach. Already, 200,000 salmon fry have been placed in the River Bran, and the River Lochay, near Killin, is also to be opened up to salmon. The Board have spent over £100,000 on these activities, in addition to improving the supply of compensation water to keep the fish alive.

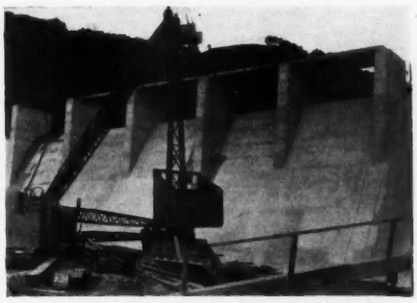
DEVELOPMENT OF LIGHT INDUSTRIES

With regard to their main purpose of supplying electricity, some figures given to us by Sir Hugh Mackenzie, deputy chairman of the Board, are of interest. During 1949, in the districts of Dingwall, Gairloch, Ullapool and Lochinver, and Caithness, they connected 1,008 new consumers, bringing the total up to 10,115. In 1953, up to November 30, in the same districts, they provided supplies to 2,163 new consumers, bringing the total up to 17,593. This represents an increase of 93 per cent. in the five years. The total number of potential consumers in this area is 21,700, so that only about 4,000 still await supplies.

The Board have recently announced a big distribution scheme for Morayshire, and their latest proposal is to spend about £350,000 on supplying current to Strathspey, Strathnavin and on to Foyers. It is hoped that this will lead to a considerable development of light industries in that area.

Meanwhile, in addition to the men actually employed on the sites, many more in different parts of Scotland (and, indeed, of England also) are benefiting by the contracts placed. The main contractors for the Glascarnoch, Vaich, Luichart and Achanalt works are Messrs. Reed and Mallik, Limited, whose headquarters are at Salisbury ; for the Meig dam and the Luichart power station, Messrs. Duncan Logan (Contractors), Limited, of Muir of Ord ; for the Glascarnoch and Vaich tunnels, Messrs. A. M. Carmichael, Limited ; for the Glascarnoch power station, Messrs. James Campbell & Son, Limited ; and for the Glascarnoch pipeline, Messrs. P. and W. Maclellan, Limited, Glasgow, who are also responsible for the Luichart pipeline and the railway bridge on the same site. The Luichart and Meig tunnels are being driven

Luichart Dam under Construction.



Spillways of Luichart Dam.

by Messrs. George Wimpey, Limited, and Messrs. Mapco, Limited, have carried out the diversion of the railway at the head of Loch Luichart except for the provision and laying of the track, for which Messrs. Thos. W. Ward, Limited, of Sheffield, were the contractors. The Torr Achilty dam and power station are being constructed by Messrs. William Tawse, Limited, of Aberdeen. The generating plant and its erection are mainly in the hands of the Metropolitan-Vickers Electrical Company, the English Electric Company, Bruce Peebles and Company, and Glenfield and Kennedy, Limited. The consulting engineers for the whole scheme are Sir Alexander Gibb and Partners, of Westminster.

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LAYING PEDESTRIAN CROSSINGS

Pre-cast Coloured Concrete Slabs

The problems involved in procuring a durable road surface that will be distinguishable as a pedestrian crossing have led to some investigations being made by the Road Research Laboratory to devise satisfactory methods of laying the alternate black and white stripes used to denote the so called " zebra " crossings. To provide a good contrast at night, so that the crossings can easily be seen, the white stripes have a smooth finish while the black are left rough.

Where the coloured surface of the crossing has been laid *in situ*, the white-concrete stripes have been placed between black mastic asphalt; the top surfacings have been between 1 in. and 2 in. in thickness and have been laid over a concrete base of up to 9 in. thick. To ensure that the white stripes were white throughout their depth, a calcined flint has been used for the aggregate, and an extra whiteness has been gained by the addition of 5 per cent. of titanium oxide. The roughness of the black stripes has been achieved by rolling pre-coated chippings into the spread asphalt.

As an alternative, which reduces the period during which the road has to be at least partially closed to traffic, the black and white stripes can be formed using pre-cast concrete slabs. Various thicknesses of slab have been used, but those made recently have had only $\frac{3}{4}$ in. of coloured concrete, being backed by 1 to 2 in. of uncoloured high quality concrete. These blocks were bedded on a layer of mortar above a concrete base and the joints filled with either black or white mortar.

Some of the crossings have been subjected to continuously heavy traffic but are showing little sign of wear after some years service. The life depends on the quality of workmanship; it is thought that this can make the difference between a life of 20 years and one of two years.

OPERATING EQUIPMENT FOR A BASCULE BRIDGE

FULLY AUTOMATIC ELECTRICAL CONTROLS

All the electrical drives and cabling for the bascule spans of the Jubilee bridge at Barrow-in-Furness have been replaced to enable the complete sequence of operations involved in raising and lowering the bridge to be fully automatic and under the control of a single handwheel. The new electrical equipment has been supplied through the General Electric Company, Limited, Kingsway, London. The main contractor responsible for the installation was W. H. Smith and Company, Electrical Engineers, Limited, Blackburn.

MECHANICAL EQUIPMENT

The bridge, shown below, was first opened in 1908 to relieve the steam ferry service then operating across the Walney Channel between the mainland at Barrow and Walney Island, which had grown as the dormitory area serving the then ever-expanding shipyards of the town.

The total length of bridge is more than 1,100 ft., comprising eight fixed spans, ranging from 82 ft. 8 in. to 117 ft. 10 in. in clear length, and an opening span of 120 ft. having a clear headway of 18 ft. above high water. The two leaves of this span open on the Scherzer rolling lift system, the principle of which is indicated in the accompanying drawing.

The rear part of each side of the leaf is formed of a segmental girder which rolls on a longitudinal track, rectangular holes in each segment corresponding with projections on the track. The driving motor, mounted inside the leaf, is coupled through gearing to a driving shaft carrying two pinions, one on each side of the leaf. Each pinion engages a rack rigidly supported on a framework fixed to the piers. The raising operation carries the whole leaf back from the opening of the bridge so that a tilt of less than 75 deg. is sufficient to give a clearance through the opening which would otherwise require raising the leaves through an angle of 90 deg. In addition, by the provision of balance weights, the centre of gravity of the leaf is located at the rear of the bridge seat, thus reducing the power necessary to move the bridge.

When the bridge is in the closed position, the rear end of each leaf enters an inverted stirrup formed on an extension to the adjacent fixed span. In order to lock the leaf in this position and to minimise deflection under passing loads, two eccentric locking pawls are provided. The shaft actuating the pawls is driven, through worm gearing, by a small motor attached to the fixed span, the rotation of the shaft driving the pawls home against seatings on the rear ends of the main girders of the leaf. The rear end of the Barrow leaf is shown opposite.

The front ends of the leaves are designed to close with an interlocking action to prevent hammering due to passing loads. The main girder of the Barrow leaf is provided with an extension in the form of a jaw, which engages with a corresponding extension on the other leaf to provide a solid lock.

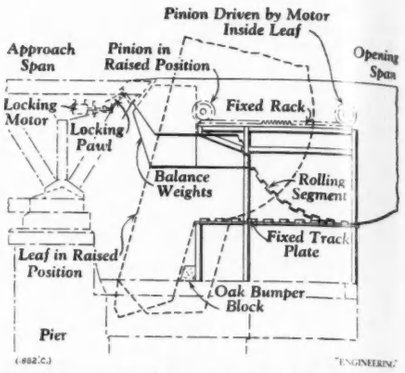
Each leaf is driven by a 25-h.p. direct-current motor, having a maximum speed of 400 r.p.m. The motors, of totally-enclosed construction, are mounted inside the leaves, and each is supplied through a flexible cable from its own Ward Leonard motor-generator set in a control cabin adjacent to the rear end of the leaf concerned. A stand-by motor is also provided on each leaf and may be connected in circuit by a change-over switch in the control gear. A magnetic brake is fitted on the main driving shaft of each leaf.

Each Ward Leonard set comprises a 35-h.p. three-phase squirrel-cage motor directly coupled to a 0/440-volt direct-current generator. The motor is supplied at 400 volts from the local mains, while the 230-volt direct-current supply to the generator-field circuit is obtained by means of a three-phase transformer-rectifier unit, which also provides the excitation for the leaf motor and the magnetic-brake solenoids.

The rear locking device on each leaf is driven through worm gearing by a 1-h.p. motor connected through reversing contactors to the supply. A slipping clutch is provided on the motor shaft, and the supply to the motor is maintained for a brief period after the pawls have reached the locked position, the machine being designed to withstand the stalling current. These arrangements ensure that the pawls are fully home before the motor is stopped.

TRAFFIC CONTROL AND NAVIGATION

Traffic gates at each end of the opening span are closed by hand before the bridge is raised. Red lights and bells on each approach give warning to traffic before the bridge is opened, and shipping is warned by two solenoid-operated semaphores. These are mounted on masts erected on platforms, at each side of the bridge. In addition, four white navigation lights are provided to indicate the extremities of the opening. These lights are switched on automatically at night, independently of the bridge system.



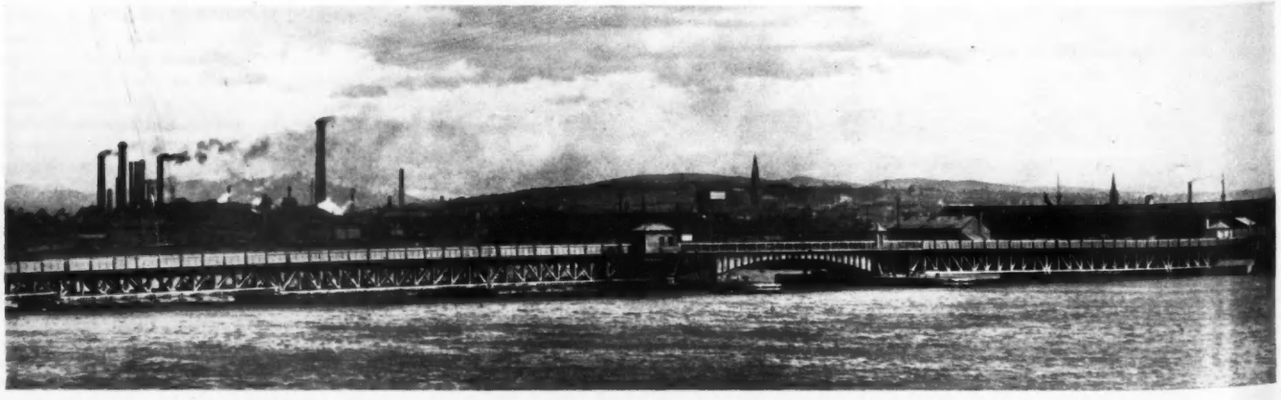
Principle of the Scherzer rolling lift system for bascule bridges. The rolling motion, which is obtained by means of the pinion on the axis of the segment, moves the bascule leaves apart as well as raises them.

CONTROL GEAR

All the control gear is in two cabins at the ends of the opening span. Two control panels, one in each cabin, house the starters for the Ward Leonard sets, the control gear for the generators, leaf motors, locking motors and magnetic brakes, and the transformer-rectifier units providing the direct-current supplies. These are controlled by the operator on the Barrow side of the bridge.

Main and auxiliary isolators and fuses for the incoming supplies are mounted on the Barrow control panel, which also houses the main line contactor ; this must be closed before any of the motors can be started. The " start " and " stop " push-buttons controlling the contactor are mounted on the desk, and an " emergency stop " push-button is provided in each cabin. The starters for the motor-generator sets are of the automatic star/delta type. The Walney set starts as soon as the operator presses the " start " push-button, but a timing device delays the starting of the Barrow set for a few seconds in order that the peak starting currents shall not occur simultaneously.

Both leaf motors are provided with two-stage overload protection. For comparatively small overloads, the first-stage relays reduce both motors to creeping speed. For heavier overloads, however, the second-stage relays disconnect the machines from the supply. The



Jubilee Bridge, Barrow-in-Furness, as seen from Walney Island. All the electrical equipment for the double-bascule opening span has been replaced by modern equipment.

stand-by motor on each leaf can be connected in circuit from the Barrow cabin, the change-over switch for the Barrow machines being mounted on the control panel, and that for the Walney motors on the operator's desk.

Raising or lowering the bridge is initiated from the desk by a single master controller, a "raise/lower" selector switch being provided to set the controller. Since these positions are not exactly the same for both duties, two sets of labels are fitted behind semi-opaque screens, one set only being illuminated, according to the setting of the selector switch. Thus, only the relevant instructions are visible to the operator. An additional switch is provided on the desk to select the appropriate navigation semaphore.

Once the raising or lowering sequence has been started, the timing of operations is regulated by limit switches which also operate indicating lamps on the control desk. The operator is therefore fully informed of progress.

INSTRUMENT FOR INDICATING MOVEMENT

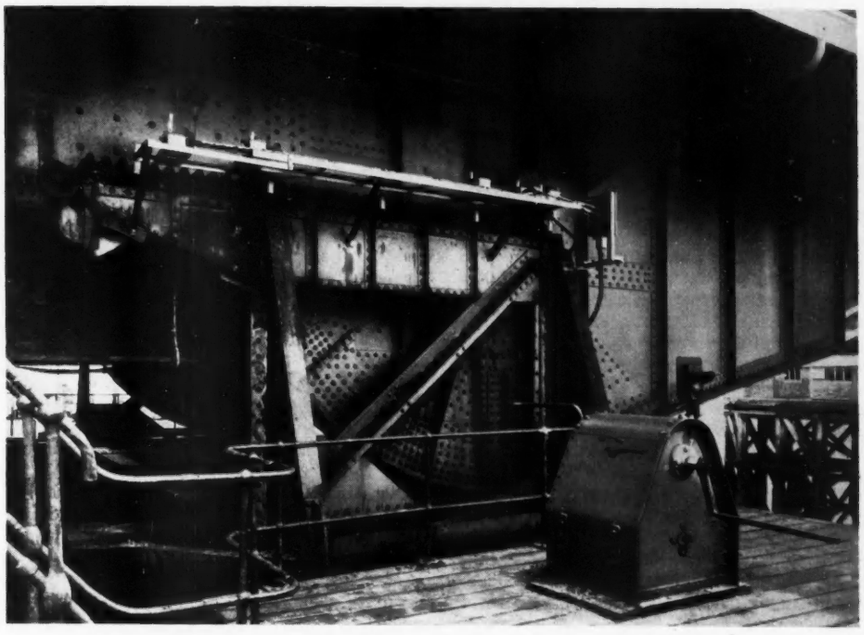
An accurate and continuous picture of the position of the leaves of the bridge is given by an indicator mounted on the desk. This instrument, manufactured by Salford Electrical Instruments, Limited, Silk-street, Salford, consists of two moving iron voltmeter movements mounted in one case. Each movement is energised from a potential divider driven from the main pinion shaft of one of the leaves, its setting corresponding to the position of the leaf. Thus, the movements of the pointers over their scales, which are calibrated in degrees, depict the movements of the associated bascules.

To raise the bridge, the leaf motor change-over switches and the semaphore selector switch are first set to the positions required. The main selector switch is then placed in the "off" position and the "start" push-button depressed, thus closing the main line contactor. The motor-generator set in the Walney cabin immediately starts and runs up to speed, followed by the Barrow set.

The operator next sets the main selector switch to "raise," thus illuminating the appropriate labels on the master controller, which is now moved fully over in the "raise" direction. This switches on the red lights on the traffic gates and the warning bells are sounded. When the passage of traffic over the bridge has ceased, the operators on both sides close their respective gates. Immediately the gates are closed, limit switches stop the warning bells and connect the supply to the locking motors, which start to disengage the rear locking devices, and the "locked" indicating lamps are extinguished.

When the pawls have been fully withdrawn, the operation of other limit switches energises the raise control relay. This connects the leaf motors to their generators, which are simultaneously excited in the required direction. The leaves now begin to rise at creeping speed. When they have risen through 5 deg., a pin on the pinion shaft operates a limit switch beside the longitudinal rack. This energises an accelerating relay which cuts out, step by step, a series resistor common to the field circuits of both generators, thus causing both leaf motors to accelerate up to full speed. The leaves continue to rise until one of them has risen through 69 deg., at which point the accelerating relay is de-energised and the motors decelerate to creeping speed.

As each leaf reaches 74 deg., a final limit switch disconnects the leaf motor from its generator and applies the brakes. When both leaves have reached the raised position, the semaphore is lowered to show that the bridge is open, and indicating lamps inform the operator that the raising operation is completed.



Rear end of the Barrow leaf of the Jubilee Bridge showing the rolling segments and the limit switches mounted beside the rack. In the foreground is the emergency manual operating gear.

To close the bridge, the selector switch is set to the "lower" position, changing the labels of the master controller to those required for the lowering sequence. Simultaneously, the navigation semaphore rises and, when both semaphores are set at danger, a circuit is completed through the "lower" relay. If the controller is now moved into the "lower" direction, this relay is energised and reconnects the generator field circuit to give reversed excitation and, at the same time, connects the leaf motors to their respective generators. The motors, therefore, accelerate to full speed, lowering the bridge.

LOCKING MOVEMENTS

When either leaf reaches an elevation of 15 deg., it stops until the other leaf has reached the same elevation. Both motors then continue to run at creeping speed. The Walney leaf stops as soon as it reaches 10 deg. elevation, the Barrow leaf continuing to fall until, at 5 deg. elevation, it also stops. The Walney leaf then restarts and travels down until it reaches the Barrow leaf, thus engaging the interlocking extensions on the front ends of the leaves. The Barrow leaf is now restarted and both bascules are driven home. When both leaves are fully lowered, the "lower" relay is de-energised and the locking motors started. As previously stated, these motors continue to run for about ten seconds after the limit switches on the locks have operated, thus ensuring that the pawls are fully home. Lamps in both cabins are illuminated when the bridge is locked; the operators now open the traffic gates by hand, the red gate lights being extinguished as soon as both gates are fully open. Other lamps indicate when the bridge is open to road traffic and the motor-generator sets may then be shut down by pressing the "stop" push-button.

If necessary, the separate stages in the operation of the bridge can be controlled by moving the master controller only to the required position. If, for example, instead of turning the controller fully in the "raise" direction, it is moved only to the "unlock" position, the raising operations continue automatically until the pawls are fully disengaged. Nothing happens beyond this stage until the master controller is moved on. In cases of emergency, all motors can be stopped instantaneously and the brakes applied by pressing the "emergency stop" push-button in either cabin. The button must then be reset before operation of the bridge can recommence.

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MODEL OF EARLY RADIO APPARATUS

Gift to Science Museum

Working models of the spark transmitter and coherer receiver with a Morse inker, such as were used by Marconi in his early radio experiments have, at the request of the authorities, been installed in the Science Museum, South Kensington. They represent equipment which was used in this form of communication for many years, although the coherer was replaced by the magnetic detector about 1902. Improved forms of spark transmission were used both for land and marine transmission until as late as 1930, when they were largely replaced by valves. The system is, however, still employed for certain emergency purposes.

The apparatus, with the exception of the inker, was made by Mr. R. W. Piper, chief of tests at the East Ham Depot of the Marconi International Marine Communication Company, who, years ago, had practical experience with this type of equipment. The inker is a commercial instrument of the period and was provided by the British School of Telegraphy.

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ANGLO-AMERICAN MATERIALS HANDLING AFFILIATION

The Institute of Materials Handling, 20-21, Took's Court, Cursitor-street, London, E.C.4, announce that an affiliation has been effected with the American Material Handling Society, Inc., for the international advancement of materials handling and for promoting understanding and co-operation between the two organisations. The affiliation in no way affects the independence, autonomy and control of either organisation.

EMPLOYMENT IN BRITAIN

MORE PEOPLE AT WORK

Statistics issued by the Ministry of Labour and National Service on January 7 showed that there were some 23,524,000 men, women and juveniles at work in Great Britain at the end of November last year, representing a net increase of 17,000 persons during that month. There were, in fact, 5,000 fewer men and boys at work at the end of November, but the number of women and girls in gainful employment rose by more than 22,000. Unemployment figures declined by 902 during the three weeks ended December 7.

Of the total working population at the end of November, 15,926,000 were men and boys, and 7,598,000 women and girls. These figures were appreciably higher than those obtaining twelve months previously, at the end of November, 1952, when there were 15,894,000 men and boys at work, and 7,479,000 women and girls. The total working population, comprising all persons aged 15 years and over who are employed in return for pay or gain of any kind, or who register themselves as available for such work, thus numbered 23,373,000 persons at that date, or approximately 151,000 fewer than at the end of November last year.

As will be seen from the accompanying table, the total number of persons employed in the basic industries was higher at the end of June last year than at the close of the previous November. The number of such persons continued to rise from June until the end of August, when a total of 4,091,000 was reached, but it tended to decline steadily from then onwards. In the mining and quarrying industries, the slight rise in the number of miners employed, and in the number of wage-earners listed on colliery books, during the first half of 1953, was not maintained after the end of June. Each month since then brought about a decline in numbers under both headings. Numbers employed in the gas, electricity and water industries remained steady throughout the year. In the transport and communications industry, there was a persistent falling away in the number of workpeople. In agriculture and fishing, numbers rose until the end of August, and then declined during the following three months for seasonal reasons.

Persons employed in the various manufacturing industries increased appreciably in number between November, 1952, and last June, and the total rose at a much higher rate from June onwards, so that at the end of November last, there were no fewer than 227,000 more people at work in this section of civil employment. Numbers engaged in most of these industries were higher in June last than in November, 1952, and higher still at the close of November, 1953. Increases in employment in the vehicle-building and textile industries are particularly worthy of note.

METALS AND ENGINEERING

An exception to the general upward trend was the metals-manufacturing industry, in which employment declined until June last and continued to fall during the following month; but, during August, a recovery in the number of employees commenced, and this was subsequently maintained, except for a slight decline in the total at the end of September.

In the engineering, metal-goods and precision-instrument group of industries, persons at work declined in number by 40,000 during the seven months to the end of June last and thereafter advanced by 52,000, to a total of 2,577,000 at the end of November last. This, however, represented an overall advance of only 12,000 for the whole twelve months, and most of that net increase, 9,000 persons, took place during the month of November.

Employment in the "other occupations" group, comprising building, contracting, distribution, the professions, financial and other services, local administration, and the Civil Service, was well maintained, and showed a substantial increase at the end of the twelve months, in spite of occasional small declines during some periods. At the end of November last, there were still 1,316,000 persons serving the Government and various local authorities.

Altogether, at the end of November last, there were 22,349,000 persons in civil employment, of whom 14,887,000 were men and boys, and 7,462,000 were women and girls. Persons registered at Ministry of Labour exchanges as unemployed at that date totalled some 322,000, of whom about 12,000 were only temporarily disengaged. In addition, at the same date, there were 857,000 persons in the Armed Forces, including 24,000 women. This was a smaller number than at the close of November, 1952, when the total stood at 874,000, and also included 24,000 women.

On December 7 last, there were 321,793 persons registered with the Ministry as unemployed, of whom 201,916 were men aged 18 years or over, 107,963 were women aged 18 years or over, 5,550 were boys, and 6,364 were girls. Of the total, 11,930 persons were only temporarily out of work, due mostly to changing from one job to another; 86,280 had been disengaged for not more than two weeks; 91,840 had been unemployed for between two and eight weeks; and 131,743 had been disengaged for longer than two weeks. Unemployment in early December was 1·5 per cent. of the estimated total number of employees, the same percentage as at the commencement of November, and compared with 1·9 per cent. in early December, 1952.

OVERTIME

The number of operatives reported as working short time in manufacturing establishments rendering returns for the pay-week ended November 28, 1953, was just over 30,000, or about the same number as was reported to the Ministry in the returns for the three months ended August 29, 1953. On the other hand, more than 1,500,000 operatives were reported to be working overtime, an increase of 180,000 on the August total. In all the figures in this article part-time employees are counted as full units.

As a footnote to the foregoing, it may be mentioned that the U.S. Department of Commerce announced in Washington on January 6 that there were 1,850,000 unemployed persons in the United States at the end of December, 1953.

ANALYSIS OF CIVIL EMPLOYMENT.

An analysis of the total number of persons engaged in civil employment, by broad industrial groups, is given in the following table.

Industry or Service.	End November, 1952.	End June, 1953.	End October, 1953.	End November, 1953.	Change during November 1953.
			(in thousands)		
Basic Industries—					
Mining and quarrying	875	876	866	865	− 1
(Wage earners on colliery books)	(719)	(720)	(710)	(709)	(− 1)
Gas, electricity and water	374	373	374	376	+ 2
Transport and communications	1,737	1,726	1,714	1,707	− 7
Agriculture and fishing	1,062	1,092	1,077	1,047	− 30
Persons in basic industries	4,048	4,067	4,031	3,995	−36
Manufacturing Industries—					
Chemicals and allied trades	487	489	500	501	+ 1
Metals manufacture	561	541	546	548	+ 2
Vehicle building	1,112	1,121	1,145	1,148	+ 3
Engineering, metal goods and precision instruments	2,565	2,525	2,568	2,577	+ 9
Textiles	944	979	1,002	1,008*	+ 6
Clothing	681	701	712	712	
Food, drink and tobacco	861	872	887	887	
Other manufactures	1,494	1,495	1,545	1,551	+ 6
Persons in manufacturing industries	8,705	8,723	8,905	8,932	+27
Other occupations—					
Building and contracting	1,422	1,448	1,445	1,443	− 2
Distributive trades	2,670	2,641	2,675	2,714	+39
Professional, financial and miscellaneous services	3,950	3,991	3,961	3,949	−12
Public administration—					
National government service	600	595	592	591	− 1
Local government service	729	725	725	725	
Persons in other occupations	9,791	9,400	9,398	9,422	+24
Total persons in civil employment	22,124	22,190	22,334	22,349	+15

* Cotton, 295,000; wool, 223,000; other textiles, 490,000. Part-time employees are counted as full units.

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THE UNITED STEEL COMPANIES, LTD.

Record Iron and Steel Production in 1953

The output of ingots at the constituent steel works of the United Steel Companies, Limited, 17, Westbourne-road, Sheffield, 10, totalled 2,374,687 tons in 1953. This is a new record for the firm and is higher by about 160,000 tons than the previous record, which was 2,216,427 tons and was attained in 1952. The steel-ingot production of the various works, in 1953, in tons, is as follows, the 1952 output being given in brackets. The Appleby-Frodingham Branch, Scunthorpe, Lincolnshire, 1,018,117 (943,262); the Steel, Peech and Tozer Branch, Rotherham, Yorkshire, 820,328 (778,824); the Workington Branch, Workington, Cumberland, 284,029 (265,655); and the Samuel Fox Branch, Stocksbridge, near Sheffield, 252,213 (228,686).

The firm's production of pig iron, including ferro-alloys, also reached the record level of 1,374,554 tons during the past year. The 1952 production was 1,358,661 tons. Of these totals, the Appleby-Frodingham Branch made 972,100 tons in 1953 and 968,045 tons in 1952, and the Workington Branch, 402,454 tons in 1953 and 390,616 tons in 1952.

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TRIPLE-POLE MERCURY SWITCH CONTACTOR

A new 60-ampere triple-pole mercury switch contactor has been placed on the market by Londex, Limited, 207, Anerley-road, London, S.E.20. It is designed for voltages up to 500, and by using a resistor in series with the relay coil the energy demand can be limited to 9 volt-amperes.

Labour Notes

WAGE INQUIRY BEGUN

The case of the engineering unions for an all-round increase of three shillings in the pound in the wages of adult men was opened before the court of inquiry for the engineering industry, in London, last Tuesday. The court, which was set up by Sir Walter Monckton, the Minister of Labour and National Service, to inquire into the causes of the wage dispute and to report thereon, held its first meeting, in public, on January 8, when certain points of procedure were decided.

Officials representing the unions and the Engineering and Allied Employers' National Federation expressed their willingness to submit an agreed statistical report dealing with employment in the industry, wage rates, and the recent history of wage negotiations.

Lord Justice Morris, the chairman of the court, outlined some of the matters on which information was desired, and said it would be helpful if the court might be supplied with a schedule showing the main changes in wage rates during recent years, and if the members might see the principal agreements between the parties governing the existing wage structure, and receive a full explanation of these agreements. They would also like to have a brief summary of wage negotiations since 1938, with particular reference to the period since 1946.

Other matters upon which information would assist the court, Lord Justice Morris said, were details of what classes of work the industry covered, the numbers of firms and individuals engaged in the industry, the number of firms belonging to the Engineering and Allied Employers' National Federation, what trade unions were concerned, the number of workpeople involved in the claim and the nature of their engineering work, the numbers of operatives in the various categories of employment, and the number of persons working overtime in the industry at various dates.

Information on the conditions governing the payment of overtime was desired, as well as full particulars of what the 3*s*.-in-the-pound wage claim involved and its effect on piecework earnings. Lord Justice Morris said he had not referred to the larger questions of living costs, profits, productivity and exports because these were all issues of the first importance which it was being taken for granted would be fully developed by the parties in their submissions to the court.

He stated that similar information would be helpful in connection with the investigations of the court of inquiry appointed by the Minister of Labour for the shipbuilding industry. That court would also like to know how many persons were employed in shipbuilding as opposed to ship-repairing.

The inquiry into the shipbuilding wage claim was not expected to commence until yesterday. Both courts, which have the same membership, are expected to complete their investigations by the end of next week, and their reports are likely to be available before the end of February.

ELECTRICAL-CONTRACTING EMPLOYEES' WAGE CLAIMS

So completely at variance were the two sides of the electrical-contracting industry early last week on the issue of the men's demands for a "substantial" wage increase, that the employers' organisation, the National Federated Electrical Association, formally reported the dispute to the Minister of Labour on January 6, in accordance with the provisions of the Industrial Disputes Order. The Association had previously offered to take the lead in submitting the claim to arbitration, if the Electrical Trades Union would agree to that course being pursued. The union declined to agree.

Conciliation officers of the Ministry were informed by the Association on January 6 that its council had decided to offer an increase in wages of 1½*d*. an hour, subject to two conditions; the first being that the increase should not apply to work done in certain areas in East Anglia or on the South coast of England, where electrical-contracting firms were having difficulty in obtaining work. The other condition was that the union should agree to payments for overtime being reduced from time-and-a-half rate to time-and-a-third rate for the first six hours worked beyond ordinary time in any working week.

This offer was reported by the Ministry's officials to representatives of the union, who replied that they were willing to commence negotiations immediately if the Association would remove the conditions attaching to their offer. Alternatively, if the employers would increase wage rates immediately by the 1½*d*. an hour suggested, without conditions, the union would accept arbitration on the question of whether any further increase should be conceded. The Association, however, was unable to accept these proposals. Mr. Harold Watkinson, the Parliamentary Secretary to the Ministry, thereupon invited the union to suspend its proposals for strike action, in view of the dispute having been formally referred to the Minister.

In an endeavour to counter the union's strike threats, the Association announced that for every day during which an employee joined in a strike, there would be no work available for him on one further day. Operatives participating in the proposed general stoppage on January 18 would not be given work on January 19.

STRIKE ACTION COMMENCED

It was reported on Monday that stoppages had occurred in connection with new electrical-installation work at the Sellafield Atomic Research Establishment in Cumberland, at a Royal Air Force Station at Pembrey, Carmarthenshire, and at an electricity-generating station near Llanelly, but that altogether only a small number of operatives were involved.

Some trouble was experienced by the union in connection with a stoppage stated to have been arranged to take place in Scunthorpe, Lincolnshire. Members of the union employed on installation work at the Appleby-Frodingham Steel Company's new ironworks voted last Friday against taking part in sporadic strikes. They were called to a special meeting on Monday and addressed by the union's whole-time President, Mr. F. Foulkes. Voting after the meeting on whether strike action should be taken was by show of hands and Mr. Foulkes stated later that the result had been very close. He added, however, that he had ordered the men to cease work, some last Tuesday and the others last Wednesday.

Mr. W. C. Stevens, the union's general secretary, expressed satisfaction with the early results of the union's activity and said that the strikes would be rapidly extended. The policy of stopping work for short periods only would be followed by more drastic measures. As from yesterday, stoppages would be of indefinite duration at some sites. This action would be spread until about two thousand electricians, in the employ of some 20 firms, would be involved.

The director of the Association, Mr. L. C. Penwill, stated on Monday that it appeared that many of the men concerned in strikes on that day had taken part unwillingly, fearing that their union would fine or suspend them if they did not co-operate. In view of that, the employers did not desire to penalise them. The Association had, however, worked out certain measures to counter the strikes and these it would put into operation if future developments warranted that course.

MINERS EXPECT NEW WAGE OFFER

A suggestion that there was every possibility that the National Coal Board would put forward a "positive offer" to increase miners' wages, when representatives of the two sides of the coal-mining industry meet next Wednesday, was made by Mr. Abe Moffat, President of the Scottish area of the National Union of Mineworkers, at a meeting of Kent miners at Aylesham last Sunday. Should the union's demands not be conceded, Mr. Moffat declared, it would mean that wages and conditions in the industry were less favourable at the present time than they were in 1947.

When the offer from the Board was received, a national delegate conference would be called by the union to decide whether it was acceptable. If the offer did not reach the standard expected by the union, and if the union rejected the offer, then, as a powerful union, the men's organisation could appeal to the country to see the hypocrisy of the Government's action in congratulating the men upon their producing nearly 212 million tons of coal during 1953 and, at the same time, declining to give them a standard of living comparable to that of 1947.

With respect to Saturday working, the time had surely come when miners were entitled to a standard of living based on a five-day week. On an average, one-fifth of all coal produced was burned by domestic consumers and this section of the community paid from £6 to £7 a ton for their supplies. How much was paid for the other four-fifths, Mr. Moffat said, was something of a mystery. The price paid per ton for coal sold to industry had never been announced in Parliament and was not known to the miners' leaders. Why did the price remain a secret ?

In answer to a question as to whether the present was a suitable time for a general stoppage in the industry, he said that such action would not come about just because he, himself, asked for it. National strike action could be taken only if the miners as a whole were convinced that such a course was necessary. If a united feeling were to be created throughout the industry, along the lines of recent meetings in Scotland, where there was some return to the spirit of 1926, then action along the lines suggested might be on the way.

COAL SALES BELOW COST

Complaints that the Board had been selling coal at below cost price to industrial consumers were made by Mr. S. Unsworth, President of the Lancashire area of the N.U.M., in his opening address at the annual conference of the area at Bolton on January 9. Industries which had obtained coal at less than cost had made substantial profits in 1952, when the deficit of the Board stood at 14 million pounds, and when it had lost some £8,500,000 by the sale of coal imported from abroad.

Miners had a right to expect that the gas, electricity, iron and steel, and similar industries should pay an economic price for the coal they used. That was the only way by which the Board's deficit balance could be eliminated. Unless these industries paid a fair price, the Board's deficit would remain for ever, to be used as an argument against an increase in the men's wages, in spite of the fact that such an argument was neither logical nor reasonable.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Railway Signalling," by J. P. Coley. National Lecture. 2, Savoy-hill, W.C.2. Tues., Jan. 19, 6.30 p.m.

MANCHESTER
"Developments of Germanium Crystals," by A. Betteridge. Engineers' Club, Manchester. Wed., Jan. 20, 7.30 p.m.

SOUTHAMPTON
"An Introduction to High-Frequency Heating," by R. J. Webb. Polygon Hotel, Southampton. Wed., Jan. 20, 8 p.m.

British Institution of Radio Engineers

EDINBURGH
Film Evening. Scottish Section. Department of Natural Philosophy, The University, Edinburgh. Wed., Jan. 20, 7 p.m.

GLASGOW
Film Evening. Scottish Section. 39 Elmbank-crescent, Glasgow, C.2. Thurs., Jan. 21, 7 p.m.

Chemical Society

LONDON
Various short papers. Thurs., Jan. 21, 7.30 p.m.

ABERDEEN
"New Outlooks in Electrochemistry," by Professor W. F. K. Wynne-Jones. Robert Gordon's Technical College, Aberdeen. Thurs., Jan. 21, 7.30 p.m.

BRISTOL
"New Methods in Analytical Chemistry," by Dr. R. Belcher. Department of Chemistry, The University, Bristol. Thurs., Jan. 21, 7 p.m.

GLASGOW
"Investigation of Natural Products Derived from Wood," by Professor F. E. King. Royal Technical College, Glasgow. Fri., Jan. 22, 7.15 p.m.

LIVERPOOL
"Fluorescence," by Dr. E. J. Bowen. Joint Meeting with Royal Institute of Chemistry, Society of Chemical Industry and British Association of Chemists. The University, Liverpool. Thurs., Jan. 21, 5 p.m.

Diesel Engine Users Association

LONDON
"Operating Experience with Gas Turbines, with Particular Reference to the Beznau Plant," by E. A. Kerez. Caxton Hall, Victoria-street, S.W.1. Thurs., Jan. 21, 2.30 p.m.

Incorporated Plant Engineers

BLACKBURN
"Power Factor Correction," by C. W. Sutcliffe. Grosvenor Hotel, Lord-street, Blackburn. Thurs., Jan. 21, 7.30 p.m.

CARDIFF
"Gas and Oil Engines," by A. C. Yeates. South Wales Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., Jan. 19, 7.15 p.m.

GLASGOW
"Instrumentation." Discussion. Scottish Building Centre, 425/427 Sauchiehall-street, Glasgow. Wed., Jan 20, 7 p.m.

ROCHESTER
"Corrosion." Discussion. Bull Hotel, Rochester. Tues., Jan. 19, 7 p.m.

Institute of British Foundrymen

CHIPPENHAM
"Pattern Making," by S. A. Horton. Bristol and West of England Branch. Works of Westinghouse Brake and Signal Co., Ltd., Chippenham. Sat., Jan. 23, 3 p.m.

NOTTINGHAM
"Investigations on Dust Problems in Foundries," by E. Morgan and P. J. Moseley. East Midlands Branch. Gas Showrooms, Nottingham. Sat., Jan. 23, 6 p.m.

Institute of Fuel

LEEDS
"Hot-Blast Cupola Practice," by W. J. Driscoll. Yorkshire Section. The University, Leeds. Wed., Jan. 20, 6.30 p.m.

Institute of Marine Engineers

LONDON
"Turbines," by John Brown. Junior Lecture. Mon., Jan. 18, 6.30 p.m.
"Gas Turbines," by J. C. Barr. Junior Lecture. Borough Polytechnic, S.E.1. Wed., Jan. 20, 7 p.m.
"Boiler Water Treatment," by C. J. Hasler. Junior Lecture. Wandsworth Technical College, S.W.18. Fri., Jan. 22, 6 p.m.

Institute of Metals

BIRMINGHAM
"The Philosophy of Science," by Professor S. Toulmin. Imperial Hotel, Temple-street, Birmingham. Thurs., Jan. 21, 6.30 p.m.

Institute of Refrigeration

LONDON
"Steam-Jet Refrigeration: Its Principles, Design, Operation, and Industrial Application," by L. L. Forster. Institution of Mechanical Engineers, 1 Birdcage-walk, S.W.1. Tues., Jan. 19, 5.30 p.m.

Institute of Welding

LONDON
"Steel Making and Welding," by Dr. L. Reeve. North London Branch. The Polytechnic, Regent-street, W.1. Thurs., Jan. 21, 7.30 p.m.
"Tubular Steel Structures," by N. B. Elliott. South London Branch. 2 Savoy-hill, W.C.2. Thurs., Jan. 21, 6.30 p.m.

Institution of Civil Engineers

LONDON
"The Engineer Task in Future Wars," by Major-Gen. G. N. Tuck. Tues., Jan. 19, 5.30 p.m.

BIRMINGHAM
"Land Reclamation in England and Holland," by W. H. Haile. Midlands Association. Joint meeting with Institution of Electrical Engineers (South Midland Centre) and the Institution of Mechanical Engineers (Midland Branch). Midland Institute, Paradise-street, Birmingham. Wed., Jan. 20, 6.30 p.m.

Institution of Electrical Engineers

LONDON
"The Role of the Consulting Engineer." Discussion, to be opened by T. G. N. Haldane. Mon., Jan. 18, 5.30 p.m.
"The Teaching of Magnetic Materials." Discussion, to be opened by Professor F. Brailsford. Education Discussion Circle. Wed., Jan. 20, 6 p.m.
"High-Sensitivity Wattmeters." Discussion, to be opened by Dr. A. H. M. Arnold. Measurements Section. Tues., Jan. 19, 5.30 p.m.
"Electricity in the Wool-Textile Industry," by A. J. Francis and T. H. Carr. Utilization Section. Thurs., Jan. 21, 5.30 p.m.

LIVERPOOL
"Researches on Circuit-Breaking by Means of High-Voltage Circuit-Breakers, with Special Reference to Current-Chopping," by A. F. B. Young. Mersey and North Wales Centre. Royal Institution, Colquitt-street, Liverpool. Mon., Jan. 18, 6.30 p.m.

LOUGHBOROUGH
"Technical Colleges and Education for the Electrical Industry," by Dr. H. L. Haslegrave. East Midland Centre. Loughborough College, Loughborough. Tues., Jan. 19, 6.30 p.m.

SOUTHAMPTON
"Alternating Current on Ships," by B. C. Pyle. Southern Centre. Technical College, Southampton. Wed., Jan. 20, 6.30 p.m.

WEYMOUTH
"Receiving Aerials for British Television," by F. R. W. Strafford. Southern Centre. Technical College, Weymouth. Fri., Jan. 22, 6.30 p.m.

Institution of Locomotive Engineers

LONDON
"Wearing Parts of Electric Rolling Stock: A Review of the Experience on the London Transport System," by A. W. Manser. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Jan. 20, 5.30 p.m.

Institution of Mechanical Engineers

LONDON
"On the Graphical Solution of Transient Vibration Problems," by Dr. R. E. D. Bishop. Applied Mechanics and Education Groups. Fri., Jan. 22, 5.30 p.m.

BRIGHTON
"Future of Marine Propulsion," by Captain (E) W. Gregson. Southern Branch. Technical College, Brighton. Wed., Jan. 20, 7 p.m.

GLASGOW
Repetition of Presidential Address, by A. Roebuck. Scottish Branch. Royal Technical College, Glasgow. Thurs., Jan. 21, 7.30 p.m.
"Manufacture and Properties of Automobile Suspension Springs," by Dr. C. J. Dadswell, J. E. Russell and R. Fielding. Scottish A.D. Centre. 39 Elmbank-crescent, Glasgow. Mon., Jan. 18, 7.30 p.m.

LEEDS
"The Jaguar Engine," by W. H. Heynes. North-Eastern A.D. Centre. The University, Leeds. Wed., Jan. 20, 7.30 p.m.

MANCHESTER
"History and Development of Flexible Couplings for the Transmission of Power Between Rotating Shafts," by A. Flindle. Annual Meeting. North-Western Branch. Engineers' Club, Manchester. Thurs., Jan. 21, 6.45 p.m.

Institution of Mining and Metallurgy

LONDON
"Observation of Dust in Mines by an Illumination Method," by W. B. Lawrie, A. T. Holman and E. B. James. Geological Society, Burlington House, Piccadilly, W.1. Thurs., Jan. 21, 5 p.m.

Institution of Production Engineers

BIRMINGHAM
"Trade Unions and Engineering Production," by Tom Wylie. James Watt Memorial Institute, Birmingham. Wed., Jan. 20, 7 p.m.

DERBY
"Punched Cards in Industry," by R. H. Skevington. College of Art, Green-lane, Derby. Mon., Jan. 18, 7 p.m.

EDINBURGH
"American Production Methods," by J. T. Fitzgerald. North British Station Hotel, Edinburgh. Wed., Jan. 20, 7.30 p.m.

GLASGOW
"Comparison Between American and British Productivity," by J. T. Fitzgerald. 39 Elmbank-crescent, Glasgow, C.2. Thurs., Jan. 21, 7.30 p.m.

NEWCASTLE-UPON-TYNE
"A Ship is Born," by N. M. Hunter. North-Eastern Section. Neville Hall, Newcastle-upon-Tyne. Mon., Jan. 18, 7 p.m.

PORTSMOUTH
"Steam Turbine Manufacture." Discussion. Southern Section. Municipal College Annexe, Portsmouth. Wed., Jan. 20, 7 p.m.

Institution of the Rubber Industry

GLASGOW
"Rubber in Locomotives." Discussion. Scottish Section, 39 Elmbank-crescent, Glasgow, C.2. Tues., Jan. 19, 7.30 p.m.

Institution of Sanitary Engineers

BATH
"Chlorination of Water," by E. A. Whitlock. Forte's Restaurant, Milson-street, Bath. Wed., Jan. 20, 6 p.m.

Institution of Structural Engineers

BIRMINGHAM
"True Economics in Planning, Designing and Detailing of Structures," by W. G. Carter. Midland Counties Branch. James Watt Memorial Institute, Birmingham. Fri., Jan. 22, 6 p.m.

LEEDS
"Reconstruction of a Soaking Pit Building," by H. C. Husband and K. H. Best. Yorkshire Branch. Great Northern Hotel, Leeds.. Wed., Jan. 20, 6.30 p.m.

Junior Institution of Engineers

LONDON
"Aspects of the Issue of Technical Information to Industry," by J. C. Y. Baker. Townsend House, Greycoat-place, S.W.1. Fri., Jan. 22, 7 p.m.

Manchester Association of Engineers

MANCHESTER
"A Geared-Diesel Whale Catcher," by F. Brooks. Engineers' Club, Manchester. Fri., Jan. 22, 6.45 p.m.

Reinforced Concrete Association

LONDON
"Recent Research in Reinforced Concrete at Imperial College," by Professor A. L. L. Baker. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Wed., Jan. 20, 6 p.m.

Royal Aeronautical Society

SOUTHAMPTON
First Mitchell Memorial Lecture, by J. Smith. Institute of Education, The University, Southampton. Thurs., Jan. 21, 7 p.m.

Royal United Service Institution

LONDON
"Science in War," by Dr. O. H. Wansbrough-Jones. Wed., Jan. 20, 3 p.m.

Sheffield Society of Engineers and Metallurgists

SHEFFIELD
Presidential Address: "Some Reminiscences," by R. E. S. Fisher. Mon., Jan. 18, 7.30 p.m.

Society of Chemical Industry

LONDON
"Metallurgical Aspects of Dry Corrosion," by Dr. L. B. Pfeil. Corrosion Group. Chemical Society, Burlington House, Piccadilly, W.1. Wed., Jan. 20, 6.30 p.m.

Television Society

LONDON
"American Television," by J. Sieger. Thurs., Jan. 21, 7 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"Beneficiation of Ores: Recent Developments in Northamptonshire Practice," by A. Stirling. Fri., Jan. 22, 6.45 p.m.

The address of the headquarters of each Institution is given in the following list. Meetings held in the headquarters town are held at this address unless otherwise stated. Particulars for insertion in this column should reach the Editor not later than Monday morning in the week preceeding the date of the meeting.

Association of Supervising Electrical Engineers, 54 Station-road, New Barnet, Hertfordshire.
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1.
Chemical Society, Burlington House, Piccadilly, London, W.1.
Diesel Engine Users Association, 56 Victoria-street, London, S.W.1.
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham.
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3.
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1.
Institute of Marine Engineers, 85 The Minories, London, E.C.3.
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1.
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3.
Institute of Welding, 2 Buckingham Palace-gardens, S.W.1.
Institution of Civil Engineers, Great George-street, London, S.W.1.
Institution of Electrical Engineers, Savoy-place, Victoria-Embankment, London, W.C.2.
Institution of Locomotive Engineers, 28 Victoria-street, London, S.W.1.
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1.
Institution of Mining and Metallurgy, Salisbury House, Finsbury-circus, London, E.C.2.
Institution of Production Engineers, 36 Portman-square, London, W.1.
Institution of the Rubber Industry, 12 Whitehall, London, S.W.1.
Institution of Sanitary Engineers, 118 Victoria-street, London, S.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1.
Junior Institution of Engineers, 39 Victoria-street, London, S.W.1.
Manchester Association of Engineers, 20 Booth-street, Manchester, 2.
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1.
Royal Aeronautical Society, 4 Hamilton-place, London, W.1.
Royal United Service Institution, Whitehall, London, S.W.1.
Sheffield Society of Engineers and Metallurgists, The University, St. George's-square, Sheffield.
Society of Chemical Industry, 56 Victoria-street, London, S.W.1.
Television Society, 164 Shaftesbury-avenue, London, W.C.2.
West of Scotland Iron and Steel Institute, 39 Elmbank-crescent, Glasgow, C.2.